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ABSTRACT

The purpose of this guide is to highlight some broad areas in which teachers and other adults have exceptional opportunities to encourage and enjoy teaching children science. Each area in the book provides some hands-on ideas for projects as well as an annotated list of readily available resources that might prove helpful on the topic at hand. The resources include numerous print materials and selected videos, tapes, kits, and models, as well as a listing of agencies, magazines, or other references where additional information may be secured. Activities described are in the following areas: physics; chemistry; biology; botany; ethology; geology; paleontology; astronomy; geography; cartography; marine biology; and exploring science through writing, art, one's senses, and in the library. Contains an index and a glossary (JRH)

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A TEACHER'S SCIENCE COMPANION

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A Teacher's Science Companion

A Teacher's Science Companion

Dr. Phyllis J. Perry

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For
Casey, Clare, and Julia,
who asked the questions,

David,
who helped with the answers, and

M.K.H.,
who never lost faith.

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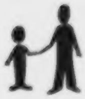
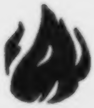
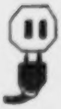
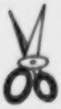
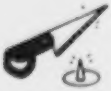
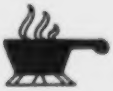
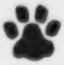
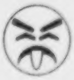
About the resource books

The listings of resources at the end of each chapter are the primary content of the book. This book was envisioned as a teacher's/parent's resource first, and a project book second. Special emphasis has been given to the resources to make them as clear and easy for the reader to find as possible. For this reason, the author chose to format the resources in a simplified manner, with the title of the book first in each listing. Resources highlighted with an asterisk (*) are specifically geared toward children of preschool age.

Symbols used in this book

adult supervision		fire	
electricity		scissors	
sharp object		stove	
animal safety/proper handling of animals and insects		dangerous chemical	

Introduction

Kids are curious, and that curiosity can be a springboard to learning. Within the school setting, teachers guide the child's educational development. Many learning opportunities can also be found in interactions between a child and other adults outside of school.

Parents, grandparents, relatives, caregivers, scout and church group leaders, librarians, neighbors, and family friends, as well as teachers, may play a significant role in developing the talents of all children. These adults serve as role models, listeners, and cheerleaders; provide space and materials for activities; allow opportunities for growing independence; and encourage creativity.

Our society has become very mobile, and today it is both a rare and fortunate child who is surrounded by an extended family. Often a child's relatives and adult friends are scattered throughout the country and may have contact only by letter, telephone, and occasional visits. Even where contact is infrequent or must bridge considerable distances, there are opportunities to provide support and a positive influence.

Adults want to make the most of the time they have to spend with children. They can be guides in the backyard examining a cricket or the stars, at a museum looking at dinosaur bones, in a planetarium or library studying space travel, or in the kitchen or classroom explaining chemistry while cooking. They may provide an introduction to optics, machines, or orienteering. They may help unlock treasures and answer questions through library research.

But the curiosity of a child is far ranging, and the questions he or she poses can be specific and come so fast and furiously that few adults feel they have all the answers. Although many people who interact with children have a background in math and science, as well as lengthy and rich life-experiences to help them, they may be unfamiliar with current children's books, video, tapes, kits, or models on specific topics outside of their own areas of expertise. Even educators find it difficult to keep up with all the new materials being released. This book provides those lists of needed up-to-date resources.

A Teacher's Science Companion promotes an interdisciplinary approach to learning. In life, things are not neatly compartmentalized. For example, the child who is interested in studying deserts or mountains in geography soon learns that maps and cartography skills are also needed. Likewise, the youth making a model of the planets quickly learns that mathematics is an essential tool. Indeed, learning about and using mathematical skills are important parts of each chapter of *A Teacher's Science Companion*.

The urge to impart what one learns requires that writing also be incorporated in science education. For example, recording notes on science experiments in journals, writing detailed observations of animal behaviors, or expressing some of the joy of science through poetry are a few of the ways writing skills are used by young scientists. Likewise, sketching a wildflower in the field or making a diagram of an insect's body parts are other examples of the interdisciplinary example approach to teaching through the use of art.

Many children and adults love games. The applicability of games can be a method of using math and science principles in an exciting problem-solving setting. For this reason, a variety of games are scattered throughout the chapters in this book.

The book begins with Chapter 1 "Exploring Chemistry in the Kitchen." This leads easily to an exploration of energy, machines, and models, as emphasized in Chapter 2 "Exploring Physics." Next the focus moves to the backyard where children make general observations, learn about habitats, and become familiar with environmental concerns and what they can do to help out planet earth (Chapter 3 "Exploring Science in the Backyard").

In Chapters 4, 5, 6, and 7, the general exploration of plants, insects, rocks, and so forth in the backyard is narrowed to more in-depth explorations. In Chapter 4 "Exploring Botany" the child is encouraged to explore the neighborhood garden, local parks, and beyond. Differences are noted among plants of the jungle, the desert, and the arctic. Spores, seeds, runners, pollination, and unusual plants, including fungi and carnivorous plants, are explored.

In Chapter 5 "Exploring Ethology" the child is invited to study birds and small mammal behavior. There is an exploration of geology and paleontology (Chapter 6) through the study or rocks, fossils, and dinosaurs; and then a focus on the field of astronomy (Chapter 7). Some of the explorations in these chapters move the child from home, school, and neighborhood to a botanical garden, zoo, natural history museum, or planetarium in the community.

Chapters 8, 9, 10, and 11 take the child still farther afield. Chapter 8 "Exploring Geography and Cartography" includes learning about maps, orienteering, hiking, biking, camping, and fishing. Then, in Chapter 9 "Exploring the Watery World" aquariums, ponds, lakes, and streams are investigated.

Chapter 11 "Exploring Science through Your Senses" focuses on the child and his or her senses. In making science observations, it is important to consider how we take in information. Chapters 12 and 13 show how the information that is gained through science explorations can be shared with others through writing and art.

Finally, Chapter 14 "Exploring Science in the Library" explains how learning to use computerized library holdings can further science research projects and help answer the many questions posed by curious kids. It explains about locating magazine articles, books, reference works, specialized encyclopedias, and other resources.

The concluding Glossary of terms will prove useful to both adults and the young scientist while working with this book and beyond.

The purpose of *A Teacher's Science Companion* is to highlight some broad areas in which teachers and other adults have exceptional opportunities to encourage and enjoy teaching children science. Each area in the book provides some hands-on ideas for projects as well as an annotated list of readily available resources that might prove helpful on the topic at hand. These resources include numerous print materials and selected videos, tapes, kits, and models, as well as a listing of agencies, magazines, or other references where additional information may be secured. (An immeasurable amount of computer software on the science exploration topic, not touched on in this book, is available to the public from various sources.)

A Teacher's Science Companion need not be read from beginning to end. Rather, the reader should dip into chapters in any order, as dictated by a child's interests and curiosity. One activity might lead naturally to another. Hearing about a national event, watching a television program, or spotting a rainbow, however, might spark an entirely new line of interest. With this book in hand, the caring adult and the curious child will find both ideas and resources to enrich their science explorations.

1

Exploring chemistry in the kitchen

For many children, the idea of love and caring is very much involved with food and cooking. Even the preschooler is terribly interested in what is going on in the world of pots, pans, beaters, buzzers, spoons, and spices.

The kitchen, whether at home or in the classroom, is a wonderful place in which a child can learn about foods, nutrition, and kitchen chemistry. And what a great place to apply mathematics! There are numerous opportunities to problem solve, work with fractions, measure, and make mathematical connections.

First and foremost to being involved in kitchen chemistry are the safety factors. This includes making a safe place for the young child to watch if he or she is not tall enough to see what is going on. All children need to be taught the danger of hot burners on the stove, touching things that have just come out of the oven, sharp knives, electrical outlets, and kitchen appliances, to name a few.

Many preschools and schools also encourage classroom cooking and "kitchen chemistry." Whether an oven, hot plates, or a microwave is available, the same need for teaching safety applies. The secret to success for "kitchen chemistry" in the classroom is to have sufficient adult help. One adult for every four or five children is a good ratio.

Rather than try to work with a whole class, the chemistry experiments described below can be set up in classroom interest centers. One or two adults can supervise at the chemistry center, with all children having a chance during a week to rotate through the various centers.

Take the time to explain "why" and "how" certain things are or are not to be done. This extra time in the beginning may lead to more safety-conscious children.

Opportunities for discussing nutrition, food groups, common kitchen gadgets, and kitchen chemistry will probably arise naturally at home when adults spend time in the kitchen with curious kids. In the classroom, investigations will develop out of various units of study.

A child might ask a simple question. Why does vinegar smell so funny? What does it do? This is a chance to explain about acids and bases. In your kitchen (or your school science/cooking lab) you have acids, such as sour milk, lemons, and vinegar. Ammonia and baking soda are examples of common bases. Acids and bases are chemical opposites. If you have just the right amount, one will neutralize the other. The following experiment will help show how this happens.

Creating traffic-light colors —red to green

In a pan, add 2 cups of water and 1 cup of shredded red cabbage. Bring this to a boil, then turn down the heat and simmer the cabbage for about 15 minutes.

Pour the red liquid from the pan into a glass and let it cool. When it is cool, pour a little of the red liquid into a small, clear juice glass, add ¼ teaspoonful of baking soda, and stir.

The color will change from red to deep green. The baking soda made the acidic mixture basic. Now add a drop or two of vinegar and stir. When you have added enough vinegar, the color will turn red again, showing that the mixture is now acid.

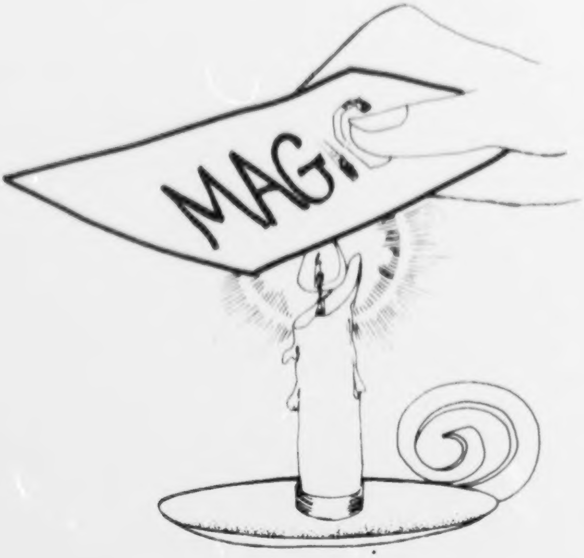
The invisible writing experiment, which also involves vinegar, allows the child to send a message in "invisible" ink.

Writing with invisible ink

If you dip a clean pen into some vinegar and write a message on a sheet of thick writing paper, making a good heavy line, the message will soon dry and disappear, leaving no trace.

Carefully light a candle and place the candle and holder in the kitchen sink. Then hold the paper an inch or two above the candle flame, moving the paper slowly back and forth to be certain it does not catch on fire. The writing will reappear, in dark brown.

The vinegar chemically changed the paper it touched. When it was raised to its *kindling temperature*, the compound on the paper where the vinegar had been smeared had a lower kindling temperature than the rest of the paper, so heat made the writing oxidize and turn brown.



Burning is also a chemical process. When something burns, it combines with oxygen. You can see how oxygen is used up in burning by planning a simple kitchen chemistry experiment.

Using oxygen

Gather the following materials: a piece of old newspaper about 6 inches square, a small drinking glass or clean jelly jar, some matches, and a metal pie pan filled with ½ inch of water.

Crumple up the piece of newspaper and stuff it in the bottom of the empty drinking glass or jar. Carefully light the newspaper with a match. When it is burning well, put the glass upside down in the water in the pie pan.

The flame will go out when the oxygen in the small glass is used up. Some water from the pan will be drawn up into the glass because the air pressure inside the glass where the oxygen has been used up is less than the air pressure outside the glass.

You can do another simple experiment with oxygen. Usually when we think of something combining with oxygen, we think of something burning as in the experiment above. But oxidation can take place under water. Bleaching is a chemical operation of this kind. When bleach is added to laundry, it whitens clothes. To show how this happens, you can conduct the following oxidation experiment.

Conducting an oxidation experiment

Fill a drinking glass ½ full of water. Add a few drops of ink. Stir until you have an even dark-blue mixture.

Add about three drops of laundry bleach. Stir. The dark-blue mixture will lose its color, becoming almost clear again, as the dye in the ink is oxidized.

Making the most of time in the home kitchen to learn science principles is tied to timing. If a busy adult is rushing to complete a series of tasks for dinner guests who are arriving in a few minutes, he or she is probably not open to holding a long conversation with a child about the interesting shapes of the sugar crystals in the sugar bowl. But on a less hurried occasion, the adult and child can talk and enjoy experimenting together.

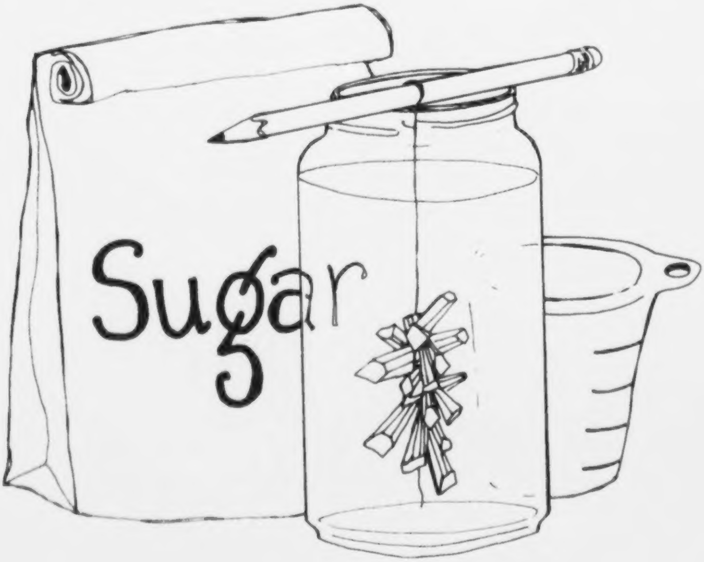
Crystals hold a special fascination for students, and are easy to study in the kitchen or the classroom. When sugar is added to water, it gradually dissolves as the sugar separates into single molecules and spreads throughout the water. Because these single molecules of sugar cannot be seen, it looks like plain water. However, the sugar, unchanged chemically, is still there, and you can get it back again.

Making sugar crystals

Put 2 cups of water into a pan and bring it to a boil. Turn the heat to low. Gradually add 3 cups of granulated sugar, stirring continuously.

Put the warm mixture into a tall glass. Across the top of the glass, lay a pencil that has a short length of cotton string tied to it. The string should almost reach the bottom of the glass when it dangles down from the pencil.

Set the glass in a warm place. In a few days, the string will be covered in many-sided crystals of sugar. As the solution cools, it forms sugar crystals that are the same shape, but larger, than the granulated sugar crystals with which you started.



If everything you have used in making these sugar crystals is clean, you can enjoy eating the "rock candy."

There are many other experiments that can be done with crystals. Many minerals have special crystal shapes by which they can be recognized. A simple experiment in crystal shape can be done with magnesium sulfate.

Creating needle crystals

Buy some Epsom salts (magnesium sulfate). Put ¼ cup of water in a small pan and heat it on the stove. Add 3 or 4 tablespoons of Epsom salts, stirring the salts in the water until no more will dissolve.

Remove the mixture from the stove and stir in two drops of ordinary liquid glue. When the glue has dissolved, take a cotton ball and swab a coating of the mixture onto a piece of glass. Set the glass aside.

In a few minutes, needle-like crystals will begin to appear. You will see them growing out in all directions. When the water has dried completely, you'll have a sample of magnesium sulfate crystals.

Kitchens and classrooms have soap. The chemical nature of soap enables it to keep small globules of oil suspended in water. Usually when your clothes are dirty, the dirt clings because a film of grease holds it. When you use soap, this film is broken down and the dirt can be washed away. The following simple experiment shows how this works.

Making an emulsion

Put an inch of water in a test tube. Then add an inch of cooking oil to the test tube. The oil will float at the top because it is less dense than the water. Hold your thumb over the end of the test tube and shake vigorously. The oil breaks up into drops. If you wait and hold the test tube still, however, most of the oil drops will come together again.

Now make a cup of soapy water. Pour about an inch of soapy water into a test tube. Then add an inch of cooking oil. Hold your thumb over the end of the test tube and shake it. This time you get a milky white emulsion. It will take a long time for the oil to separate out.

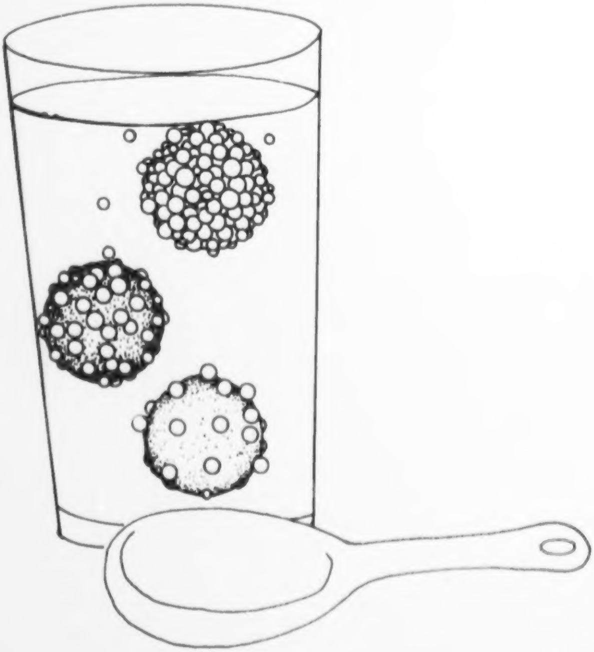
There are many interesting kitchen chemistry experiments involving the properties of yeast and baking soda. Kids may wonder, for example, why soda pop is so fizzy or bubbly. Soda drinks are made by forcing carbon dioxide gas into the water that contains sweetener and flavoring. The gas is dissolved in the water. When you open the bottle or can, the carbon dioxide appears as small bubbles in the liquid and give the drink its bubbly taste.

This is a simple experiment with carbon dioxide.

Making mothballs move

Pour one tablespoon of vinegar into a 6 oz. glass of water. Add one tablespoon of baking soda. Then drop three moth balls into the glass and wait.

You will soon see tiny bubbles forming on the moth balls. These bubbles are carbon dioxide, which form on the rough sides of the moth balls. When enough bubbles form, they act like floats and will raise the moth balls to the top of the liquid. Then some of the bubbles will break off, and the moth ball will slowly sink.



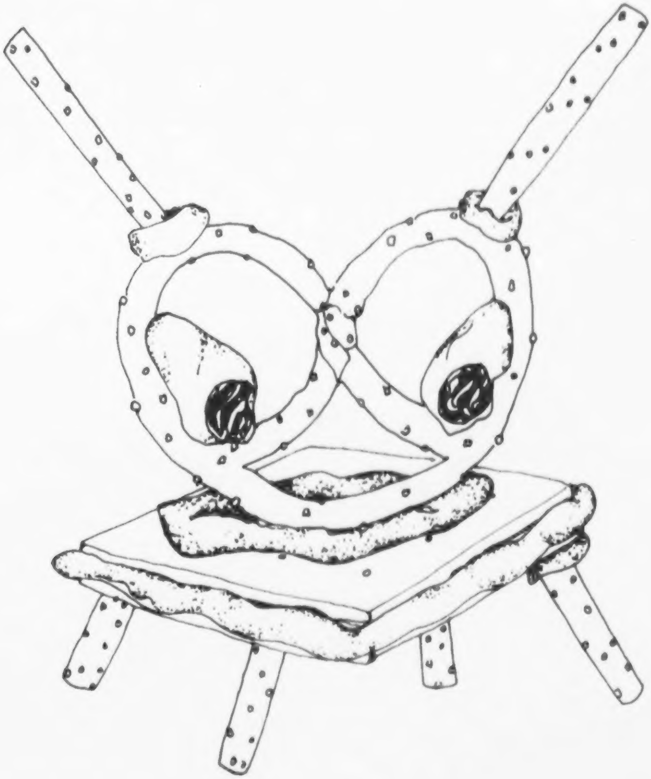
More bubbles will gather, and the moth ball will rise again. This will go on for a long time until all the chemicals are used up.

Although we have discussed the kitchen and classroom as a place for chemistry experiments, the chapter would not be complete if we didn't have at least one opportunity to enjoy some food to eat.

Being fanciful with food can be a lot of fun. With the tremendous variety of snack foods we have available to us, a snack food science sculpture could be an exciting class or home activity that requires no cooking at all.

Sculpting snack food science

Gather together some pretzels, crackers of different shapes and sizes, and some soft cheese spread. Encourage children to make fantastic snack food sculptures that can be admired and then eaten for an afternoon treat.



Depending on the age of the children and the science topics being studied, they may turn snack food into an unusual machine, a spaceship, or a sea creature.

Exploring chemistry and nutrition in the home kitchen or in the classroom can be satisfying and fun for adults and for curious kids. The resources that follow contain easy recipes for children to make simple foods. Included are books featuring foods from different countries and that are connected with special holidays, adding the social studies interest to science experimentation.

Resource books

Adventures with Atoms and Molecules, Book 3: Chemistry experiments for young people. Robert C. Mebane and Thomas R. Rybolt. Hillside, NJ: Enslow Pub., 1991. 96 pp. Simple chemistry experiments for home or school.

Adventures with Atoms and Molecules, Book 4: Chemistry experiments for young people. Robert C. Mebane and Thomas R. Rybolt. Hillside, NJ: Enslow Pub., 1992. 96 pp. Contains chemistry experiments for home or school that demonstrate properties of atoms and molecules.

Atoms: Building blocks of matter. Timothy L. Biel. San Diego, CA: Lucent Books, 1990. 96 pp. Presents experiments that were done by famous scientists in the fields of physics and chemistry.

Betty Crocker's Cookbook for Boys and Girls (rev. ed.). Betty Crocker (Editors). New York, NY: Golden Press, 1984. 94 pp. Includes sample recipes, discusses basic techniques of cooking, and explains the use of various utensils.

Bread. Dorothy Turner. Minneapolis, MN: Carolrhoda Books, 1989. 32 pp. Tells how bread is produced and prepared and gives some background along with two recipes.

Bread, Bread, Bread. Ann Morris. New York, NY: Lothrop, Lee & Shepard Books, 1989. 32 pp. Discusses many different kinds of bread.

Chemical Changes. Kathryn Whyman. New York, NY: Gloucester Press (imprint of Franklin Watts), 1986. 32 pp. Explains chemical changes.

Chemically Active!: Experiments You Can Do at Home. Vicki Cobb. New York, NY: J. B. Lippincott, 1985. 154 pp. Contains many experiments to do at home.

Chemistry. Shirley Cox. Vero Beach, FL: Rourke Pub., 1992. 48 pp. Explains scientific method and discusses science fair chemistry projects.

Chemistry. Steve Parker. New York, NY: Franklin Watts, 1990. 40 pp. Illustrates basic principles of chemistry through experiments and tricks.

Chemistry for Every Kid: One hundred and one easy experiments that really work. Janice Pratt Vancleave. New York, NY: John Wiley & Sons, 1989. 232 pp. Gives instructions for conducting experiments.

Chemistry Magic: Learning Chemistry through Fun-Filled Experiments. Edward Palder. Kensington, MD: Woodbine House, 1987. 153 pp. Teaches through chemistry experiments.

Chemistry: The birth of a science. Tom McGowen. New York, NY: Franklin Watts, 1989. 96 pp. Traces the history of chemistry from the ancient world to the late 18th century.

Consumer Chemistry Projects for Young Scientists. David E. Newton. New York, NY: Franklin Watts, 1991. 112 pp. Suggests experiments that demonstrate the basic principles of chemistry using household items.

Cooking Wizardry for Kids. Margaret Kenda and Phyllis S. Williams. New York, NY: Barron's, Inc., 1990. 314 pp. Contains instructions for nearly 200 creative kitchen projects including invisible ink, cakes, puddings, and salads.

Everyday Chemicals. Terry J. Jennings. Chicago, IL: Childrens Press, 1989. 34 pp. Provides an introduction to different kinds of chemistry through activities and experiments.

Experiments with Chemistry. Helen J. Challand. Chicago, IL: Childrens Press, 1988. 48 pp. Provides an introduction to chemistry through simple experiments.

Famous Experiments You Can Do. Robert Gardner. New York, NY: Franklin Watts, 1990. 142 pp. Shows how to replicate famous experiments to demonstrate scientific principles of chemistry and physics.

Foodworks: Over 100 science activities and fascinating facts that explore the magic of food. Ontario Science Center Staff. Reading, MA: Addison-Wesley Publishing Co. 1987. 96 pp. Contains science activities for ages 8 through 12 that explain the role of food, what it does, and how it acts in the body.

Fun with Chemistry. Paul Berman. New York, NY: Marshall Cavendish, 1988. 48 pp. A guide to projects and experiments.

Getting Ready to Cook. Stoffelina Johanna Adriana De Villiers. Milwaukee, WI: G. Stevens, 1985. 31 pp. Provides an introduction to utensils, cooking terms, hints, and recipes.

**Gobs of Goo.* Vicki Cobb. New York, NY: J. B. Lippincott, 1983. 38 pp. Experiments you can do at home.

Holiday Cooking around the World. Easy menu ethnic cookbooks, all about 46 pages, by various authors. Each book introduces the history of a country, its festivals, and food recipes. Minneapolis, MN: Lerner Publications Co.

Cooking the African Way. Constance Nabwire, 1988.
Cooking the Australian Way. Elizabeth Germaine, 1990.
Cooking the Austrian Way. Helga Hughes, 1990.
Cooking the Caribbean Way. Cheryl Kaufman, 1988.
Cooking the Chinese Way. Ling Yu, 1982.
Cooking the English Way. Barbara W. Hill, 1982.

Cooking the French Way. Lynne Marie Waldee, 1982.
Cooking the German Way. Helga Parnell, 1988.
Cooking the Greek Way. Lynne W. Villios, 1984.
Cooking the Hungarian Way. Magdolna Hargittai, 1986.
Cooking the Indian Way. Vijay Madavan, 1985.
Cooking the Japanese Way. Reiko Weston, 1983.
Cooking the Israeli Way. Josephine Bacon, 1986.
Cooking the Italian Way. Alphonse Bisignano, 1982.
Cooking the Korean Way. Okwha Chung, 1988.
Cooking the Lebanese Way. Suad Amari, 1986.
Cooking the Mexican Way. Rosa Coronado, 1982.
Cooking the Norwegian Way. Sylvia Munsen, 1982.
Cooking the Polish Way. Danuta Zamojska-Hutchins, 1984.
Cooking the Russian Way. Gregory and Rita Plotkin, 1986.
Cooking the Spanish Way. Rebecca Christian, 1982.
Cooking the Thai Way. Supenn Harrison, 1986.
Cooking the Vietnamese Way. Chi Nguyen, 1985.

How to Make a Chemical Volcano and Other Mysterious Experiments. Alan Kramer. New York, NY: Franklin Watts, 1991. 112 pp. This 13-year-old author presents 29 experiments using household chemicals and materials.

Ideas for Science Projects. Robert Gardner. New York, NY: Franklin Watts, 1989. 144 pp. Provides an introduction to scientific method and contains several experiments.

In Charge: A complete handbook for kids with working parents. Kathleen Sharar Kyte. New York, NY: Alfred A. Knopf, 1983. 115 pp. Advice for kids who get themselves off to school or who are alone when they come home from school. Includes tips on cooking and recipes.

Introduction to Chemistry. Jane Chishom and M. Lynnington. London, Eng.: Osborne Pub., 1983. 48 pp. Provides an introduction to chemistry.

Janice Vancleave's Molecules. Janice Vancleave. New York, NY: John Wiley & Sons, (in press). 88 pp. Contains a collection of science experiments and projects exploring molecules.

Janice Vancleave's 200 Gooey, Slippery, Slimy, Weird, and Fun Experiments. Janice Vancleave. New York, NY: John Wiley & Sons, 1992. 116 pp. Filled with experiments in biology, chemistry, physics, earth science and astronomy.

**Kids Cooking without a Stove: A cookbook for young children (rev. ed.).* Aileen Paul. Santa Fe, NM: Sunstone Press, 1985. 63 pp. Contains easy to follow recipes that require no cooking. Includes recipes for drinks, salads, sandwiches, desserts, and candies.

*_Kitchen Chemistry and Front Porch Physics._ Marie Agnes Hoyt. New York, NY: Educational Services Press, 1983. 60 pp. Illustrates chemistry and physics through simple activities.

*_Kitchen Chemistry: Science experiments to do at home (rev. ed.)._ Robert Gardner. Englewood Cliffs, NJ: Julian Messner, 1989. 128 pp. Filled with simple science experiments.

Kitchen Fun. Catherine Ripley (Ed.). Boston, MA: Little Brown & Co., 1988. 32 pp. Contains cooking and science experiments.

Kitchen Fun for Kids: Healthy recipes and nutrition facts for 7 to 12 year old cooks. Michael F. Jacobson. New York, NY: Henry Holt, 1991. 136 pp. Contains recipes for breakfast, lunch, and dinner and gives nutritional facts.

Let's Visit a Spaghetti Factory. Melinda Corey. Mahwah, NJ: Troll Associates, 1990. 32 pp. Tells where spaghetti and pasta come from and includes ways to cook pasta and how to make crafts from pasta.

Magic Tricks, Science Facts. Robert Friedhoffer. New York, NY: Franklin Watts, 1990. 126 pp. Presents several magic tricks that are based on principles of physics, mathematics, or chemistry.

Making Bread. Ruth Thomson. New York, NY: Franklin Watts, Inc., 1987. 32 pp. Describes how to make bread.

Microwave Cooking for Kids. Editors of Better Homes & Gardens. Des Moines, IA: Meredith Corp., 1984. 96 pp. Contains recipes for breakfast, lunch, supper, and for snacks, drinks, and desserts.

*_Mummy Took Cooking Lessons, and Other Poems._ John Ciardi. Boston, MA: Houghton-Mifflin, 1990. 52 pp. Contains children's poetry.

Nutrition Mission. Janis Rhodes. Carthage, IL: Good Apple, 1982. 48 pp. Explains for young children the essentials of a balanced diet and contains no-cook recipes.

Once Upon a Recipe: Delicious, healthy foods for kids of all ages. Karen Greene. New Hope, PA.: New Hope Press, 1991. 96 pp. Contains more than 50 healthy recipes with allusions to works of children's literature such as Bambi's Salad Bowl and Shakespeare's Breakfast Sandwiches.

175 More Science Experiments to Amuse and Amaze Your Friends. Terry Cash, Steve Parker, and Barbara Taylor. New York, NY: Random House, 1991. 172 pp. Experiments using common household items illustrate principles of sound, electricity, magnets, weather, and chemistry.

Out to Lunch: Jokes about food. Peter and Connie Roop. Minneapolis, MN: Lerner Publications Co., 1984. 32 pp. Contains jokes about food and cooking.

Recent Revolutions in Chemistry. James A. Corrick. New York, NY: Franklin Watts, 1986. 128 pp. Discusses the different branches of chemistry and recent theories and discoveries.

Robert Gardner's Favorite Science Experiments. Robert Gardner. New York, NY: Franklin Watts, 1992. 128 pp. Contains science experiments that can be done with materials commonly found at home.

*_Rookie Cookie Cookbook: Everyday recipes for kids._ Betty Debnam. Kansas City, KS: Andrews & McMeel, 1989. 126 pp. Contains easy recipes and dishes that can be prepared in a microwave.

Science for Kids: 39 easy chemistry experiments. Robert W. Wood. Blue Ridge Summit, PA: TAB Books, 1991. 32 pp. Contains 39 simple chemistry experiments.

Science Fun with a Homemade Chemistry Set. Rose Wyler. New York, NY: Julian Messner, 1987. 48 pp. Gives an introduction to the basic concepts of chemistry through simple experiments using baking powder, soap, and vinegar.

Science Magic: 101 experiments you can do. Ormond McGill. New York, NY: Arco Pub., 1984. 163 pp. Explains magic tricks that are based on science principles.

*_Sensational Science Activities with Dr. Zed. Gordon Penrose._ New York, NY: Simon & Schuster Books for Young Readers, 1990. 48 pp. Explains 21 projects that can be done at home in the fields of chemistry, physics, and biology.

Simon & Schuster Young Readers' Book of Science, The. Robin Kerrod. New York, NY: Simon & Schuster Books for Young Readers, 1991. 192 pp. Surveys science, including chemistry.

Simple Chemistry. Neil Ardley. New York, NY: Franklin Watts, 1984. 32 pp. Suggests experiments to perform that illustrate basic chemical principles.

Sugaring Season: Making maple syrup. Diane L. Burns. Minneapolis, MN: Carolrhoda Books, 1990. 48 pp. Describes making maple syrup from the tapping of the tree to packaging.

Teenage Chef The, A young adult's guide to cooking. Jonathan Jackson. New York, NY: F. Warne, 1983. 86 pp. Contains 47 simple recipes.

Vicki Lansky's Kid's Cooking. Vicki Lansky. New York, NY: Scholastic Inc., 1988. 48 pp. A helpful book on kids cooking.

Wild, Wild Cookbook: A guide for young wild-food foragers. Jean Craighead George. New York, NY: Thomas Y. Crowell, 1982. 182 pp. By season, provides a field guide for finding, harvesting, and cooking wild plants.

Other resources

In exploring foods, nutrition, and kitchen chemistry, you might want to look at some of the many periodicals devoted to different aspects of chemistry. Among these are: *Analytical Chemistry, The Journal of Biological Chemistry, Chemistry and Industry, Chemical Times and Trends, Journal of Chemical Education, Journal of the American Chemical Society,* and *Journal of Organic Chemistry.*

Hidden Structure, The. Jacob Bronowski. New York, NY: Ambrose Video Pub., 1988 1 videocassette, 52 minutes. Traces the history of chemistry.

Human Skeleton Model (57–130–3323). Hudson, NH: Delta Education, Inc. *Snaps together.* Shows bones to scale.

Pumping Heart Model (57–130–3312). Hudson, NH: Delta Education, Inc. Requires assembly. Squeeze the bulb to see how "blood" flows through the arteries, veins, and heart cavities and how heart valves work.

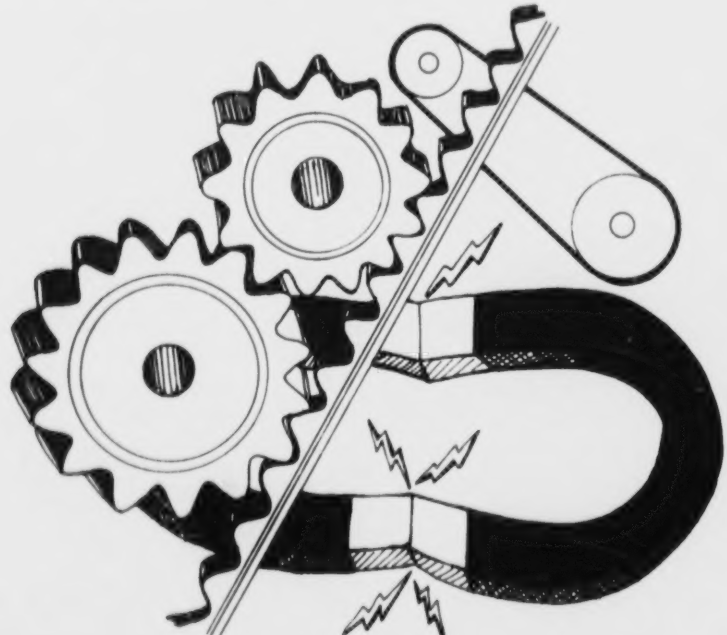
Refinery Film, The. Bravura Films, Inc. Chevron, U.S.A., Inc., 1985. 1 videocassette, 22 minutes. Explains what happens at an oil refinery and teaches a little about chemistry and physics.

2

Exploring physics

Curious kids are always wondering how things work, so experimenting with models, gadgets, and gears will probably be of great interest to them. More abstract, but equally fascinating, are investigating optics, gravity, magnetism, electricity, radio waves, and ways of using different types of energy.

Some youngsters will be amazed by the way a clock works. Others might watch with rapt attention as someone tinkers with an automobile engine, a motorcycle, or a bicycle. Still others will be caught up in the adventure of flight.



As you explore the topics in this chapter, the child's interests will be your best guide. Many of the resource books that are listed at the end of this chapter include a large number of simple experiments or activities. Most of these require only supplies and equipment that can be commonly found around your home or classroom.

Math skills will be used throughout these activities as children estimate, compute, develop a spatial sense, measure, reason and problem solve, make mathematical connections, and communicate their ideas.

Explaining how a lever works

Explain how a long lever works and the fact that by using a lever, the child can lift a person much heavier than he or she.

To set up this experiment, use a heavy 8-foot board, and put a sturdy wooden block or box under the board but close to one end.

Have a teenager or adult stand on the board at the end near the wooden support. Then have the child step onto the board at the other end. By using the lever, the child will be able to lift a person who is much heavier than he or she. Have the child take special care in getting on and off the board.

Many experiments with electricity require an electric current detector. The following experiment describes how to make one.

Making a current detector

Buy a roll of inexpensive insulated "bell wire" at a hardware store. Unwind 12 inches of wire from both ends of the roll of wire. Wrap adhesive tape around the roll to prevent it from unwinding further.

Scrape the insulation from both ends of the wire so that 1 inch of bare copper wire shows.

Tape the roll of wire upright onto a piece of wood that is about 5 inches square. Push two thumbtacks gently into the top of the wood, near the front edge, about 2 inches apart.

Wrap the end of one piece of wire once around the shaft of the thumbtack so that 10 inches of wire sticks out in front. Push the thumbtack in firmly to hold the wire in place. Repeat this procedure with the other wire and thumbtack.

Set a compass, flat and level, inside the coil of wire.

Then hold one end of the wire to the end of a flashlight battery. Hold the other wire to the opposite end.

The compass needle will swing as it detects the presence of an electric current.

Another source of energy commonly used is a battery. The following experiment shows you how to make an 11-cent battery that is much like a flashlight battery.

Making a battery

Stir 1 teaspoon of salt into a glass that is filled with 3 oz. of water.

Put a postage-stamp size piece of blotting paper in the glass to soak for a few seconds in the salt water solution.

Take out the piece of blotting paper and put it between a dime and a penny and squeeze the coins together.

Then touch one wire of your current detector to the penny and the other wire to the dime. You will see the compass needle move as electricity passes from your tiny battery through the coil.

Some of the principles of energy and simple machines can be demonstrated through activities that are easy to set up. The following experiment helps to demonstrate a little about friction.

Demonstrating friction

To demonstrate friction, cut a piece of string, pass it through a rubber band, and then tie the string around a book. Ask the child to pull the book across the table by slipping his or her finger through the rubber band and pulling.

The child will see that the rubber band stretches out long and that it is not easy to pull the book because of friction.

Then put three long, round pencils beneath the book. Have the child pull the book again. The rubber band will not stretch as far this time, and the book will be easier to pull because the pencils act like rollers and cut down friction.

A simple way to show how heat travels by conduction is demonstrated in the following experiment.

Making molecules move and make heat

Make a cup of tea or soup and pour it into a cup or bowl.

Have a child put a cold spoon into the cup or bowl of liquid and wait. Then have the child touch the spoon handle. The handle is hot even though it was never heated with the liquid.

You have demonstrated that when molecules move fast, they generate heat.

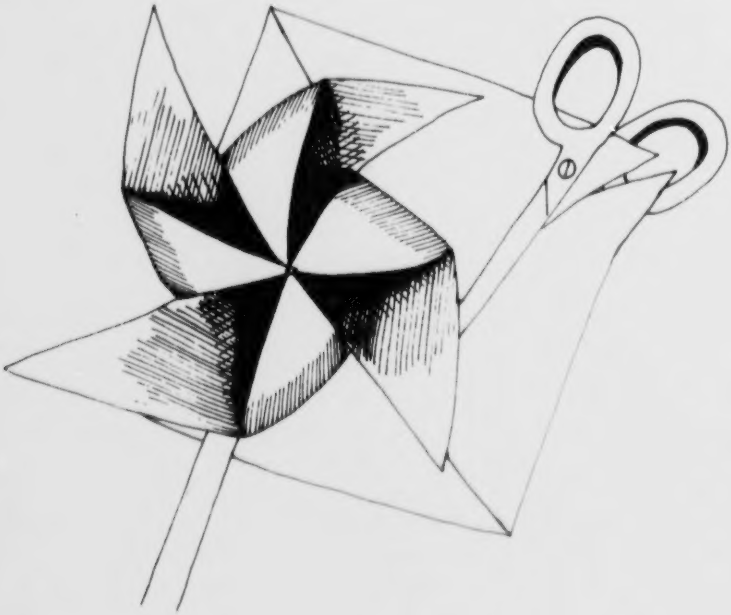
Another example of the principles of energy and simple machines can be demonstrated by building the simple windmill described in the following experiment.

Explaining wind energy

A child who sees or reads about a windmill as an energy source might want to make his or her own windmill. You will need scissors; a piece of light-weight cardboard, such as a file folder; a steel straight pin; and a dowel.

Cut the piece of cardboard into an ⅛-inch square. Mark the center. Cut from all four corners on the diagonal half-way to the center. Bend one piece of cardboard at each of the four corner points to the center.

Push your pin through all four points and gently push it into the dowel. Spin the wheel a few times around on the pin so that it turns easily.



By waving your windmill through the air or taking it outside to catch the wind, it will spin away. (If the two sides of the cardboard are different colors, the "whirl" will be especially colorful.)

An understanding of the principles of physics and chemistry can also allow a child to engage in some interesting magic tricks. One of these that may amaze others is the "obedient straw" trick.

Performing the obedient straw trick

To perform the "obedient straw" trick, you will need a plastic drinking straw, a pin, and a glass of water. Use the pin to prick a double row of tiny holes in the straw about two inches from one end. (Do this before you show your trick and be sure that the holes are so tiny that they will not be noticed.)

Tell a friend that you have an "obedient straw" that will only allow someone to drink from it if you so command. With the pin-pricked part of the straw out of the water, have a friend try to take a sip. Little or no water will come up the straw.

Pick up the straw and speak to it seriously, saying, "Straw, I command you to let my thirsty friend have a drink of water." Replace the straw in the glass. This time be sure to put the pin-pricked part of the straw down into the water. Your friend will now be able to drink from your "obedient straw."

A simple experiment involving sound can also be performed with an ordinary drinking straw.

Using straws to produce sound

Flatten one end of a straw and cut the flat end to a point. Wet the point and put that end in your mouth. While keeping your lips on the round part of the straw, blow and listen.

Then use the scissors to cut the straw shorter. Blow again. What happens to the sound? Cut the straw still shorter. What happens to the sound now? (As the straw gets shorter, the sound gets higher.)

Another simple trick, this one involving optics, can be done with a pencil. Tell a friend that you can break a pencil without touching it and also make the bottom half grow larger than the top half.

Performing the pencil trick

Fill a glass full of water. Put a long pencil in it so that the pencil point rests at the bottom side of the glass and its eraser rests at the top opposite side of the glass.

Tell your friend that you will now break the pencil and make the bottom half grow. As seriously as possible, say, "Break and grow!"

Have your friend look into the glass. The part of the pencil where it enters the water will appear broken. The pencil below the water appears slightly larger.

Your "trick" depends on the fact that light shining on the upper part of the pencil first strikes the pencil and then travels to your eyes. This light is reflected but not bent. The light that lets you see the part of the pencil below the water, travels through the water, the glass, and the air to reach your eyes. The light rays are bent. This light is slightly slower reaching your eyes and the time difference causes a distortion called refraction.

The pencil below the water looks larger because the water and the curve of the glass magnify its image.

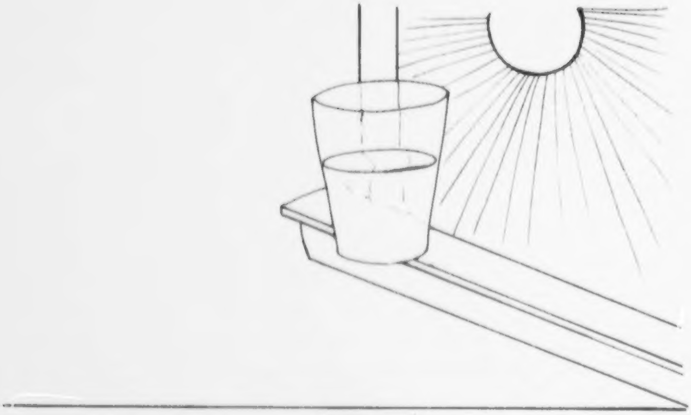
It seems that anyone who sees a rainbow must stop to admire it. Rainbows are formed when raindrops refract sunlight—when sunlight is broken into the colors of red, orange, yellow, green, blue, indigo, and violet. It isn't hard to make your own rainbow in the classroom or at home on a sunny day. The following experiment will show you how.

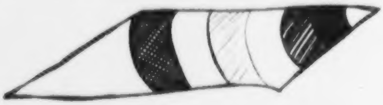
Making a rainbow

Fill a drinking glass with water and put it on a windowsill in the bright sunlight. Let the glass hang a little over the edge of the sill toward the room.

Put a large piece of white paper on the floor below the glass, positioning it so that the sun shines through the water onto the paper. You will be able to see a rainbow on the paper.

Once some of the underlying principles of physics are understood, the curious child may want to explore them in greater depth. Community resources may be very helpful here. For example, if a child shows interest in ham radio, there will be a local radio club with members who may supply useful information about setting up a rig or who may help your child with his or her studying to take a licensing test. If railroads are of interest, model railroad enthusiasts are equally willing to show and explain their setups to eager children.





Manufacturing companies often set up tours for interested people to visit a plant and see their production process firsthand. Newspaper offices may have tours of their presses, and a local airport may have a variety of aeronautical displays.

Many kits and models are available commercially for those who do not want to start experimenting from scratch. Some sources for purchasing experimenting materials are listed among the "Other Resources" in this chapter.

Resource books

Air and Flight. Barbara Taylor. New York, NY: Warwick Press, 1991. 40 pp. Contains simple experiments to demonstrate the properties of air and the principles of flight.

All about Crystal Sets: How to build crystal set radios. Charles Green. Freemont, CA: Allabout Books, 1984. 58 pp. Tells how to build a simple radio.

American Ingenuity: Henry Ford Museum and Greenfield Village. James S. Wamsley. New York, NY: H. N. Abrams, 1985. 223 pp. A guide book to the Henry Ford Museum.

Auto Mechanic, An. Douglas Florian. New York, NY: Greenwillow Books. 1991. 24 pp. Shows the daily work of an auto mechanic.

**Balancing*. Terry Jennings. New York, NY: Gloucester Press, 1989. 28 pp. Filled with science experiments involving balancing.

***Balloon Science*. Etta Kaner. Redding, MA: Addison-Wesley Publishing Co., 1990. 96 pp. Contains ideas for 50 balloon experiments.

Balloons: Building and experimenting with inflatable toys. Bernie Zubrowski. New York, NY: Morrow Junior Books, 1990. 80 pp. Contains experiments using balloons to demonstrate various scientific principles.

***Bathtubs, Slides, Roller Coaster Rails: Simple machines that are really inclined planes*. Christopher Lampton. Brookfield, CT: Millbrook Press, 1991. 32 pp. Explains the inclined plane.

Blinkers and Buzzers: Building and experimenting with electricity and magnetism. Bernie Zubrowski. New York, NY: Morrow Junior Books, 1991. 112 pp. Filled with experiments and projects.

Cars, Trucks, and Trains. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1990. 48 pp. Discusses the development of cars, trucks, and trains.

***Click, Rumble, Roar: Poems about machines*. Lee Bennett Hopkins (Editor). New York, NY: Thomas Y. Crowell, 1987. 48 pp. Contains eight poems about machines.

Clocks. Building and experimenting with model timepieces. Bernard Zubrowski. New York, NY: Morrow Junior Books, 1988. 112 pp. Gives instructions for making working models of different clocks from readily available materials.

Day in the Life of a Racing Car Mechanic. A. Carol Gaskin. Mahwah, NJ: Troll Associates, 1985. 32. pp. Follows a mechanic through a day.

Electricity. Alan Cooper. Morristown, NJ: Silver Burdett Press, 1983. 48 pp. Explains principles and uses of electricity.

Electricity and Magnetism. Terry Jennings. Chicago, IL: Childrens Press, 1989. 32 pp. Provides an introduction to magnetism, magnets, compasses, batteries, and electricity.

Electricity and Magnets. Barbara Taylor. New York, NY: Franklin Watts, 1990. 32 pp. Explains the properties of electricity and magnetism.

***Energy*. Terry Jennings. Chicago, IL: Childrens Press, 1989. 32 pp. Answers questions about uses of energy through activities and experiments.

Energy and Power. Barbara Taylor. New York, NY: Franklin Watts, 1990. 32 pp. Shows how oil, steam, electricity, and nuclear power are manipulated to provide energy.

Energy: Making it work. Tom Johnston. Milwaukee, WI: Gareth Stevens Pub., 1987. 32 pp. Examines energy and how one form of energy is converted into another.

Energy Projects for Young Scientists. Robert Gardner. New York, NY: Franklin Watts, 1989. 127 pp. Contains experiments related to solar, thermal, electrical, kinetic, and potential energy.

Energy Technology. Mark Lambert. New York, NY: Bookwright Press, 1991. 48 pp. Discusses both traditional and alternative energy resources.

Engineering Projects for Young Scientists. Peter H. Goodwin. New York, NY: Franklin Watts, 1989. 126 pp. Contains projects involving force, friction, motion, sound waves, light waves, and mechanics.

Experimenting with Air and Flight. Ormiston H. Walker. New York, NY: Franklin Watts, 1989. 96 pp. Through experiments, explains the properties of air and the mechanics of flight.

Experimenting with Energy. Alan Ward. New York, NY: Chelsea House Publishers, 1991. 48 pp. Explains fundamental concepts of energy with simple experiments using household materials.

Experiments with Electricity. Helen J. Challand. Chicago, IL: Childrens Press, 1986. 45 pp. Provides an introduction to batteries and discusses the properties of electricity with related experiments.

**Exploring Magnetism*. Neil Ardley. New York, NY: Franklin Watts, 1983. 32 pp. Contains experiments with magnets.

Exploring Uses of Energy. Ed Catherall. Austin, TX: Steck-Vaughn Library, 1990. 48 pp. Through simple projects and experiments, explains how energy is used, stored, transferred, and conserved.

**Force and Movement*. Barbara Taylor. New York, NY: Franklin Watts, 1990. 32 pp. Contains simple experiments and activities explaining about force and the ways things move.

Forces with You! Tom Johnston. Milwaukee, WI: Gareth Stevens Pub., 1987. 32 pp. Explains various forces and their effect on our lives.

Fuel and Energy. Herta S. Breitter. Milwaukee, MN: Raintree Childrens Books, 1988. 46 pp. Explains how various types of fuel are used as sources of energy.

**Get It in Gear! The science of movement*. Barbara Taylor. New York, NY: Random House, 1991. 40 pp. Through simple experiments, explains everyday machines.

Getting Started with Model Trains. John Townsley. New York, NY: Sterling Publishing Co., 1992. 96 pp. Tells about starting out with model trains.

Graphs. Ed Catherall. Chicago, IL: Childrens Press, 1983. 32 pp. Explains use of different kinds of graphs.

Gravity: The universal force. Don Nardo. San Diego, CA: Lucent Books, 1990. 96 pp. Explains the force of gravity and its effects on humans.

Great Aircraft Collections of the World. Bob Ogden. New York, NY: Gallery Books, 1986. 200 pp. Discusses aeronautical museums.

Hidden World of Forces, The. Jack R. White. New York, NY: Dodd, Mead, 1987. 143 pp. Gives many experiments to illustrate electromagnetism, gravitation, surface tension, and friction.

Invention. Lionel Bender. New York, NY: Alfred A. Knopf, 1991. 64 pp. By use of photos and texts, the reader can explore inventions such as the wheel, gears, levers, and so forth.

Letting Off Steam: The story of geothermal energy. Linda Jacobs. Minneapolis, MN: Carolrhoda Books, 1989. 48 pp. Explores geothermal energy and how it can be used as an alternative energy source.

Machines and How They Work. David Burnie. New York, NY: Dorling Kindersley, 1991. 64 pp. Contains information on how different machines work.

**Marbles, Roller Skates, Doorknobs: Simple machines that are really wheels*. Christopher Lampton. Brookfield, CT: Millbrook Press, 1991. 32 pp. Contains many experiments involving wheels.

Marshall Cavendish Library of Science Projects, The. Steve Parker. New York, NY: Marshall Cavendish, 1986. 43 pp. Contains science experiments involving mechanics, light, water, plants, earth, and the human body.

Measurement Motivators. Thomas J. Palumbo. Carthage, IL: Good Apple, 1989. 96 pp. Provides a variety of measurement activities for children in grades three through seven.

Mechanics. John Freeman and Martin Hollins. Morristown, NJ: Silver Burdett Press, 1983. 48 pp. Discusses the means by which machines work.

Modern Sports Science. Larry Kettelkamp. New York, NY: Morrow Junior Book, 1986. 160 pp. Helps children understand muscle mechanics.

Monster Wheels. Bill Holder and Harry Dunn. New York, NY: Sterling Publishing Co., 1990. 32 pp. Discusses modern monster trucks doing various tricks and stunts.

More Science Secrets. Judith Conaway. Mahwah, NJ: Troll Associates, 1987. 48 pp. Gives simple experiments to explore basic scientific principles.

More Wires and Watts: Understanding & using electricity. Irwin Math. New York, NY: Scribner, 1988. 96 pp. Presents fundamentals of electricity and magnetism through experiments and projects that produce working models.

Motorcycles. Alain Chirinian. Englewood Cliffs, NJ: Julian Messner, 1989. 64 pp. Discusses the 14 top motorcycles.

Move it! Henry Arthur Pluckrose. New York, NY: Franklin Watts, 1990. 28 pp. Discusses various sources of power such as wind, gravity, motors, and electricity.

Moving Things. Robin Kerrod. Morristown, NJ: Silver Burdett Press, 1987. 54 pp. Examines energy, sound, light, color, gravity, magnetism, and electricity.

National Air and Space Museum ABC, The. Florence Cassen Mayers. New York, NY: H. N. Abrams, 1987. 32 pp. An ABC depicting early aviation.

Now You're Talking! Discover the world of HAM radio. Newington, CT: American Radio Relay League, 1991. 255 pp. Contains information on how to become an amateur radio operator.

Nuclear Energy/Nuclear Waste. Anne L. Galperin. New York, NY: Chelsea House Publishers, 1992. 112 pp. Shows benefits of nuclear power and the problems of nuclear waste.

175 More Science Experiments to Amuse & Amaze Your Friends. Terry Casn, and Barbara Taylor. New York, NY: Random House, 1991. 176 pp. Contains experiments using common items to demonstrate the principles of sound, electricity, magnetism, and so forth.

Pedal Power: The history of bicycles. Peter Lafferty and David Jefferis. New York, NY: Franklin Watts, 1990. 32 pp. Traces the history of the bicycle.

Physics for Kids: 49 easy experiments with mechanics. Robert W. Wood. Blue Ridge Summit, PA: TAB Books, 1989. 160 pp. Explains simple physics experiments for kids.

Power Failure. Mary LeDuc O'Neill. Mahwah, NJ: Troll Associates, 1991. 32 pp. Discusses energy today and its future.

Power Magic. Alison Alexander. New York, NY: Simon & Schuster, 1991. 30 pp. Contains experiments on exploring ways to use energy.

Power Up: Experiments, puzzles and games exploring electricity. Sandra Markle. New York, NY: Atheneum, 1989. 48 pp. Ideas for exploring electricity.

Radio Controlled Model Airplanes. Suzanne Lord. Mankato, MN: Crestwood House, 1988. 48 pp. Discusses organizations, tools needed, and the building and flying of model airplanes.

Rads, Ergs, and Cheeseburgers: The kids' guide to energy & the environment. Bill Yanda. Santa Fe, NM: John Muir Publications, 1991. 108 pp. A magical being discusses the various forms of energy.

•*Sailboats, Flag poles, Cranes: Using pulleys as simple machines*. Christopher Lampton. Brookfield, CT: Millbrook Press, 1991. 32 pp. Discusses simple machines that use pulleys.

Secrets of the Universe: Discovering the universal laws of science. Paul Fleisher. New York, NY: Atheneum, 1987. 224 pp. Contains various experiments and activities to help children examine the laws of physics.

•*Seesaws, Nutcrackers, Brooms: Simple machines that are really levers*. Christopher Lampton. Brookfield, CT: Millbrook Press, 1991. 32 pp. Explains simple machines that are levers.

**Simple Science Experiments with Marbles.* Eiji Orii and Masako Orii. Milwaukee, WI: Gareth Stevens Pub., 1989. 32 pp. Shows what happens when a moving object hits something.

Skeleton and Movement, The (rev. ed.). Steve Parker. New York, NY: Franklin Watts, 1991. 48 pp. Discusses the musculoskeletal system.

Trains: The history of railroads. David Jefferis. New York, NY: Franklin Watts, 1991. 32 pp. Traces the development of trains.

Unusual Airplanes. Don Berliner. Minneapolis, MN: Lerner Publications Co., 1985. 48 pp. Discusses a variety of airplanes that have unusual shapes.

The Way Things Work. David Macaulay. Tucson, AZ: Zephyr Press, 1988. 400 pp. Contains simple explanations of complicated scientific principles.

Weight and Balance. Barbara Taylor. New York, NY: Franklin Watts, 1990. 32 pp. Discusses force, gravity, and devices used to measure weight.

Weird Wheels. Alain Chirinian. Englewood Cliffs, NJ: Julian Messner, 1989. 64 pp. Shows 14 vehicles with unusual shapes and powerful engines.

Wheels. Julie Fitzpatrick. Morristown, NJ: Silver Burdett Press, 1988. 30 pp. Experiments with wheels, pulleys, and gears.

Why Doesn't the Earth Fall Up? And other not such dumb questions about motion. Vicki Cobb. New York, NY: Lodestar Books, 1989. 40 pp. Answers nine interesting questions about motion.

Why Doesn't the Sun Burn Out? Vicki Cobb. New York, NY: Lodestar Books, 1990. 40 pp. Presents and answers nine interesting questions about energy.

Wind and Water Energy. Sherry Neuwirth Payne. Milwaukee, MN: Raintree Children's Books, 1983. 47 pp. Discusses windmills, hydroelectric plants, and geothermal reservoirs.

Wings of History: The air museums of Europe. Louis Divone. Oakton, VA: Oakton Hills Publications, 1989. 312 pp. Discusses various aeronautical museums.

Wings, Wheels, & Sails. Tom Stacy. New York, NY: Franklin Watts, 1991. 40 pp. Discusses various forms of transportation.

Work People Do, 3 bks. Betsy Imershein. Englewood Cliffs, NJ: Julian Messner, 1990. 32 pp. ea. Explains common tasks of auto mechanics.

Other resources

American Institute of Physics
Director of Physics Program
335 East 45th Street
New York, NY 10017

AM/FM Project Kit (28–175). Fort Worth, TX: Radio Shack, Tandy Corporation. Contains a pre-assembled tuner and the remainder solderless coil-spring construction. Batteries not included.

Baufix Construction Sets (57–020–9318). Hudson, NH: Delta Education, Inc. 82 pieces, with vinyl case. Durable wood and vinyl construction sets come with instructions for making cars, cranes, and other simple machines.

Capsela Kits: Capsela 200 (57–031–0826). Hudson, NH: Delta Education, Inc. Contains enough materials, with guide, for 10 projects to study gears and locomotion by building self-propelled machines. Does not include batteries.

Crystal AM Radio Kit (28–177). Fort Worth, TX: Radio Shack, Tandy Corporation. Simple materials for a crystal radio.

Cut & Assemble Paper Airplanes that Fly (57–020–8328). Arthur Baker. Hudson, NH: Delta Education, Inc. Contains eight ready-to-assemble airplanes.

Delta Gears: Gear Set (57–070–1645). Hudson, NH: Delta Education, Inc. Contains strong plastic gears, two large, two medium, and one small, with base, cover, handle, and pointer.

Delta Wheeled Carts: Wheeled Cart (57–030–3159), Magnets (57–130–0419). Hudson, NH: Delta Education, Inc. These wheeled carts with magnets demonstrate both magnetism and simple machine principles.

Electromagnet Set (57–050–0752). Hudson, NH: Delta Education, Inc. Contains materials to construct a working electromagnet, complete with battery and step-by-step instructions.

Flying Machines. Patrick Prentise. Rochester, NY: Eastman Kodak, 1989. 1 videocassette, 60 minutes. The viewer goes on a visit to the National Air and Space Museum's Paul E. Garber Facility and sees how air and space craft are restored and preserved.

Gram Mass Set (57–130–1200). Hudson, NH: Delta Education, Inc. A 10-piece set (1 g.–200 g.) that will allow students to measure weight using a brass mass set.

Henry Ford Museum & Greenfield Village. Glastonbury, CT: Video Tours, 1989. 1 videocassette, 30 minutes. Explores the Henry Ford Museum.

Invicta Simple Scale (57–191–0765). Hudson, NH: Delta Education, Inc. Young children can use this simple molded, plastic balance scale.

Lego Pneumatic Set (57–110–1231). Hudson, NH: Delta Education, Inc. Contains 124 pneumatic elements and instructions to make five models that really work.

Magnet Set (57–130–3741). Hudson, NH: Delta Education, Inc. This set contains five horseshoe magnets, five bar magnets, and a variety of metal shapes to attract.

Motorized Capsela Robot. Hudson, NH: Delta Education, Inc. The child can build a slow-motion, motorized robot from 38 snap-together parts. Gears are visible. Batteries are not included.

30-in-1 Electronic Lab Kit (28–161). Fort Worth, TX: Radio Shack, Tandy Corporation. Teaches the basics of electronics and includes everything needed to build a radio, alarm, and timer. Batteries not included.

Ultimate Paper Airplane, The. Richard Kline. San Diego, CA: Creative Learning Systems, Inc. Contains detailed diagrams and instructions for folding and flying seven models of planes.

White Wings Assembly Kit. San Diego, CA: Creative Learning Systems, Inc. Dr. Yasuaki Ninomiya, authority on paper planes, designed this kit, which contains 15 different models and includes step-by-step assembly guides and flight instructions.

3

Exploring science in the backyard

Much of a child's time is heavily regulated. This is partly due to the hectic pace of simply living in the 1990s. Often both parents work, and alarms start everyone off each day dashing in a variety of directions. There may be buses to catch, car pools to arrange, and day-care schedules to coordinate.

In addition, scattered throughout the week for various family members, there are meetings, music lessons, aerobics classes, bowling, bridge club, scouting, swimming lessons, religious activities, little league schedules, concerts, and many more activities. Although these various activities make up our "leisure time," they might not be very leisurely!

Schools are also "time conscious." Bells ring, periods end, tests and projects need to be completed within a time frame, library books need to be returned by a certain date, and so forth.

While children need discipline, they do not need to be occupied every minute of the day! Especially during the summer or while on a school vacation, a child really appreciates the opportunity to simply play in a backyard—and the backyard is a wonderful place to begin explorations in science.

Before abandoning a young child to the joys of playing and exploring science in a backyard, it is important that safety factors be considered. If the backyard is fenced and relatively free from dangerous materials, it might be sufficient for you to explain which areas, if any, are "off limits" to the child.

Children can usually accept and respect such limits, but it is helpful to give some rationale. For instance, if a portion of the flower bed has just been seeded, the child must understand that he or she cannot dig or run there because young seedlings are starting to grow and would be damaged if trampled.

With a little thought, most guidelines can be positively phrased, such as "You may dig in the dirt and play with your trucks in this area," or "You may play ball in this area," rather than listing a lot of "no's" and "don'ts."

Young children may be either quite happy exploring and playing on their own or may appreciate adult company. Sometimes they may want to bring toys or equipment outside with them. Make the most of the active imagination and curiosity of a child. For example, a very young child may be content for some time to sit on a back patio with a dish of soap bubble solution and a bubble pipe. After a time, this may lead to a series of questions about the size and shape of bubbles, what makes the colors that shine on them, and how high and fast they may float. This is your time to incorporate science.

If any child spends considerable time in the backyard, it is almost inevitable that his or her powers of observation will sharpen. Also, quite early, children may develop specialized interests. This can lead to a host of questions, half of which will begin with "Why?" Your logical, thoughtful response to a child's "why?" question may immediately be met with another "why?" question.

Often these questions that are seemingly simple are in reality quite complex. For example, the question "Why is the grass green?"

can take some time to explain! Knowing how to seize these opportunities can lead to wonderful outdoor learning situations.

These questions and outdoor explorations also provide great opportunities for the application of mathematics. The child will be using problem-solving techniques and reasoning skills, measuring and graphing, estimating and making connections, seeing patterns and relationships, and communicating mathematical findings. There will be plenty of opportunity to work with whole numbers and fractions.

When questions arise in your areas of expertise, it will be easy to answer the child simply, completely, and honestly. In a flush of enthusiasm over a loved and well understood subject, however, there is always a danger in telling too much. (We've all had the experience of being told far more about penguins than we ever wanted to know!)

And sometimes, when the questions arise in an unfamiliar field, you may be stumped. It's quite all right to tell a child that you don't know the answer to a very good question but will try to find out. This can be the beginning of an outing to the library. (Be sure to read Chapter 14, "Exploring Science in the Library.")

Sometimes questions can best be answered by observation. Sitting quietly and watching a honeybee move from blossom to blossom may answer some of a child's questions about pollination. It may also lead to checking out more books to find additional information.

The child may notice that soils are different. Some soil may be reddish clay while others are rich in humus or sandy. In Chapter 4, "Exploring Botany," some additional ideas for exploring how plants grow in different types of soil are provided.

And the activities in this chapter do not need to be limited to the backyard at home. Many teachers take students to the playground, to a nearby park, or on a more distant field trip to explore the outdoors. At the right time and in the right place, it can be amazing how much a child can learn from the observation of a square-foot of land!

Although sharp eyes and curiosity are the best equipment, if you have a budding biologist on your hands, some other items may prove useful. A notebook and pencil might be helpful, along with a magnifying glass, a butterfly net, and a specimen cage or "bug box."

Making a bug box

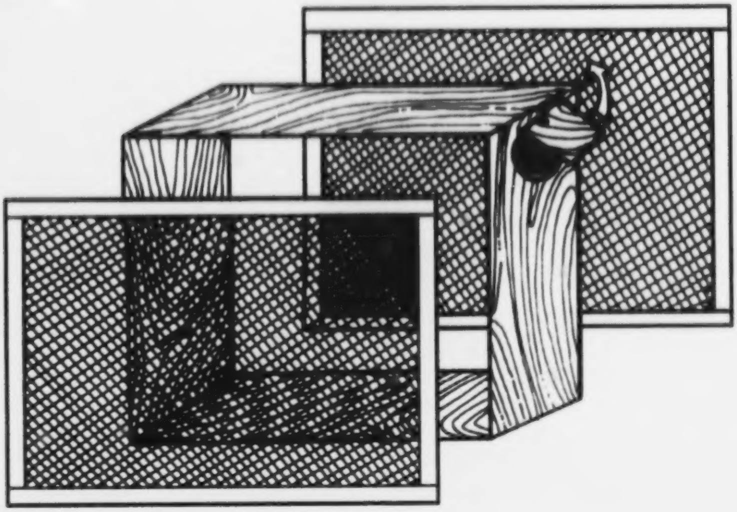
To make a bug box, cut four pieces of ¼-inch-thick plywood into rectangles that measure 6 inches high by 2½ inches wide. Into one of these pieces, 1 inch from the top edge, drill a hole, approximately 1½ inches in diameter. (This will be the hole through which specimens, leaves, and twigs are inserted.) Use fine finishing nails to hold together the bottom and two upright sides of your bug box. The side with the hole should be attached so that the hole is toward the top.

For the front and back of the bug box, use very fine screen attached inside a ½-inch wooden frame with outside measurements of 6 inches tall by 7½ inches wide.

Attach the fourth piece of ¼-inch plywood to the top to complete the box. Nail it into place. You may want to glue a handle on the top for easy carrying.

Lastly, cut a small piece of plywood or smooth particle board approximately 2 inches square. Using a short screw, fasten this 2-inch piece of wood directly above the 1½-inch hole in the side. This piece can now be pushed aside to uncover the hole for inserting specimens and pushed back into place again to secure the bug box.

Using your new bug box, the child might enjoy looking more closely at the eggs that a butterfly has attached to the leaves of your willow tree. He or she may also find great delight in a cricket or grasshopper that could be contained for a short time to allow a thorough study. Since caterpillars spend most of their time eating, it might be possible to put one along with its favorite leaf into a container and both watch and listen. (Yes, you can sometimes hear the chomping noise made by a caterpillar's jaws!) Remember, however, what you capture must be let go so it can continue to live.



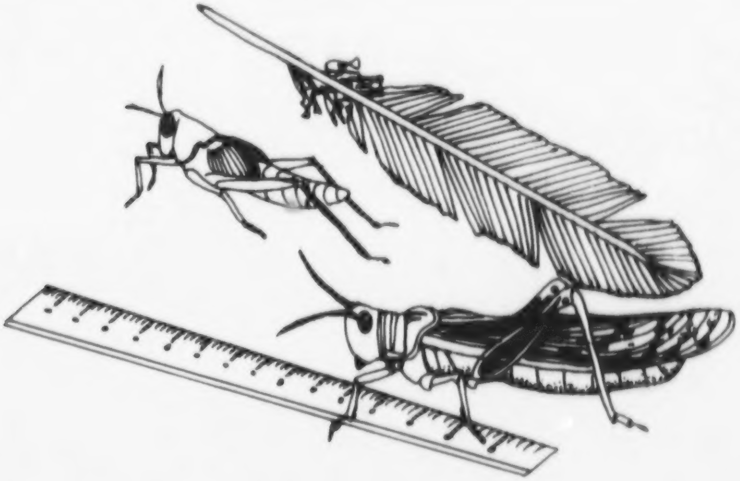
Measuring the big jump

Grasshoppers are great jumpers. Perhaps you and a curious child would like to find out just how far they can jump.

Set out a long sheet of paper, marking off a starting point. Place the grasshopper on the sheet (perhaps on a front porch or back patio). Then make the grasshopper jump by gently touching the tail end of its abdomen with a feather.

Mark the spot where it lands and measure the distance. Try this experiment with several grasshoppers and some crickets too.

If the child really seems to enjoy crickets, an activity that would keep him or her interested would be to set up a vivarium.



Setting up a vivarium at home or school

Crickets make good pets. You can make a home for a cricket by putting a layer of dirt and some leaves into an empty aquarium and placing a wire mesh on top. This new home is called a *vivarium*.

To keep the cage clean, cover the cricket with a small strainer to prevent its escape while you are housekeeping. If you keep more than one cricket, you need to be sure that you have a male and a female. If you try to keep two males or two females together, they will often fight.

Feed your pet crickets crumbs of bread, bits of lettuce and cucumber, potatoes, and even dog biscuits. Sprinkle some water for them to drink onto a plant leaf or put in a small bottle cap of water.

The backyard is home to many busy little creatures. A spider may have provided a web in the corner of the garden. The patient child may see not only the clever spider who wove the web but also the sorts of food trapped in it. An industrious ant might be observed carrying a crumb over and through the blades of grass. A mantis, camouflaged in green and brown, may look over its shoulder at the explorers in the yard. And a beetle may be surprised in the middle of its lunch on a hollyhock.

By taking the time to observe and having some very simple equipment available, you can capitalize on the natural curiosity of a child. Remember that even at a young age, children also can be taught humaneness and responsibility. For example, a grasshopper should not be kept in an airtight jar, and after the child has had a chance to study a butterfly, it should be released back into its natural environment. You can model a respect for and interest in nature.

Another way to learn more about insects is to capture them on film by photographing them. In this way, the child will have a permanent record of the insect in its natural habitat.

Using photography

You will want to use high-speed film and a fast setting since it is hard for a child to hold a camera very still. Also you will need practice in guessing the distance from the camera to the insect so that you can focus correctly. Many cameras have attachments for close-range photography.

You may also want to use a tripod to hold the camera perfectly steady and keep it in one position after it has been focused. For night photography, you'll need photo-flood bulbs.

Keeping a notebook in which you record the date, time, place, lighting conditions, film, and shutter speeds is a good habit for the young naturalist to acquire.

Some students won't be very interested in earthworms, butterflies, crickets, and grasshoppers. The creepy crawlies of the backyard or schoolyard don't appeal to them. But you needn't give up on exploration in the out-of-doors. These children may develop an interest in birds, flowers, trees, shrubs, or vegetables. Chapters 4 ("Exploring botany") and 5 ("Exploring ethology") will deal with these topics.

For apartment and city dwellers who lack backyards, there can be trips to playgrounds and city parks to observe ducks, song birds, squirrels, plants, and insect life. Even on an apartment windowsill, it's possible to encourage seedlings in an egg carton planter or to participate in planting and maintaining a small herb or bulb garden planted in a large, decorative terrarium.

Relatives or friends who live some distance from a child, might snap some photos of the yard filled with snow, a spring blossoming fruit tree, a prize rosebush in bloom, a robin's nest, a butterfly on a lily, a giant squash, or the biggest pumpkin from the patch, and mail these pictures to the child.

The richness of the backyard exploration might be enhanced by sharing some books together on special topics of interest and carrying out some simple experiments. Many of these may be related to classroom activities.

Resource books

Adventures with Rocks and Minerals: Geology experiments for young people. Lloyd H. Barrow. Hillside, NJ: Enslow Publishers, 1991. 96 pp. Contains a variety of earth science experiments.

Amazing Beetles. John Still. New York, NY: Alfred A. Knopf, 1991. 32 pp. Through photographs, examines members of the beetle world.

Animal Builders. Jim Flegg. Brookfield, CN: Newington Press, 1991. 32 pp. Tells how animals, fish, and insects build homes to protect themselves.

Animal Observations. Ray Broekel. Chicago, IL: Childrens Press, 1990. 48 pp. Provides tips on observing behavior and habitat of birds, insects, and other wildlife.

**Animals, Birds, Bees, and Flowers.* Alan Snow. Chicago, IL: Childrens Press, 1989. 24 pp. Introduces animals, birds, insects, and plants.

Ant Colony, An. Heiderose and Andreas Fischer-Nagel. Minneapolis, MN: Carolrhoda Books, 1989. 48 p. Describes the life cycle and the community life of ants.

Backyard Hunter: The praying mantis. Bianca Lavies. New York, NY: Dutton, 1990. 32 pp. Describes the behavior of the mantis.

**Bees and Wasps.* Kate Petty. New York. NY: Gloucester press, 1987. 29 pp. Includes discussion of honeybee, bumblebee, and yellow jacket.

Butterfly and Moth. Paul Ernest Sutton Whalley. New York, NY: Alfred A. Knopf, 1988. 64 pp. Using photos, the behavior and life cycles of moths and butterflies are illustrated.

Can You Find Me? A book about animal camouflage. Jennifer Dewey. New York, NY: Scholastic, Inc., 1989. 40 pp. Tells how insects, birds, reptiles, and mammals use camouflage.

Clover and the Bee, The: A book of pollination. Anne Ophelia Dowden. New York, NY: Thomas Y. Crowell, 1990. 96 pp. Explains pollination.

Creepy Crawlies. Ruth Thomson. New York, NY: Macmillan, 1991. 32 pp. Provides an introduction to ants, caterpillars, flies, snails, spiders, and worms.

Discovering Bugs. George McGavin. New York, NY: Bookwright Press, 1989. 48 pp. Describes characteristics and behavior of bugs.

Discovering Slugs and Snails. Jennifer Coldrey. New York, NY: Bookwright Press, 1987. 47 pp. Describes the physical characteristics, habitat, and behavior of slugs and snails.

Dragonfly. Barrie Watts. Morristown, NJ: Silver Burdett Press, 1989. 25 pp. Shows the development of the dragonfly through egg and nymph to adult through the use of photos and drawings.

Draw 50 Creepy Crawlies. Lee J. Ames. New York, NY: Doubleday, 1991. 60 pp. Includes step-by-step instructions for drawing 50 insects and spiders.

Earthworms, Dirt, and Rotten Leaves: An exploration in ecology. Molly McLaughlin. New York, NY: Atheneum, 1986. 96 pps. Describes earthworms and their habitat, and suggests simple experiments.

**Empty Lot, The (Vol. 1).* Dale H. Fife. Boston, MA: Little, Brown, 1991. 30 pp. In this work of fiction, Harry inspects an empty, partially wooded, lot before selling it and finds birds, insects, and other small animals.

Exploring Weather. Ed Catherall. Austin, TX: Steck-Vaughn Library, 1990. 48 pp. Discusses climate and weather, and includes simple activities and experiments.

Fingers and Feelers. Henry Arthur Pluckrose. New York, NY: Franklin Watts, 1990. 32 pp. Explores the sense of touch in the animal kingdom.

**First Look at Spiders, A.* Millicent E. Selsam and Joyce Hunt. New York, NY: Walker & Company, 1974. 32 pp. Introduces children ages five to eight to the world of the spider.

Golden Book of Insects and Spiders, The. Lawrence P. Pringle. Racine, WI: Western Publishing Co., 1990. 45 pp. Takes a look at insects and spiders.

How Did We Find Out about Sunshine? Isaac Asimov. New York, NY: Walker & Company, 1987. 64 pp. Examines scientific discoveries for children ages 10 and more.

How to Collect and Care for Beetles. Barrie Watts. New York, NY: Franklin Watts, 1989. 29 pp. Tells how to collect and care for beetles.

Insect. Laurence Alfred Mound. New York, NY: Alfred A. Knopf, 1990. 64 pp. Explores the world of insects.

Insect Almanac, The: A year-round activity guide. Monica Russo. New York, NY: Sterling Publishing Co., 1991. 128 pp. Tells how to find, identify, and keep insects and provides seasonal activities.

Insect Metamorphosis: From egg to adult. Ron and Nancy Goor. New York, NY: Atheneum, 1990. 32 pp. Explains how insects grow and change.

Insects. Elizabeth Cooper. Austin, TX: Steck-Vaughn Library, 1990. 48 pp. Introduces and describes insects including those that are helpful and those that are pests.

Insects. Terry J. Jennings. New York, NY: Gloucester Press, 1991. 24 pp. Tells how to recognize insects such as ants, butterflies, ladybugs, and bees.

Insects. Philip Steele. Mankato, MN: Crestwood House, 1991. 32 pp. Offers facts about different kinds of insects, habitats, and life cycles.

Insects. John Bonnett Wexo. Mankato, MN: Creative Education, 1991. 24 pp. Discusses the world of insects.

Insects: A guide to familiar american insects. Herbert Spencer Zim. Racine, WI: Western Publishing Co., 1991. 160 pp. Introduces the child to familiar insects.

Insects and Spiders. Linda Losit et al. New York, NY: Facts On File, 1989. 96 pp. Introduces insects and spiders, including centipedes, crickets, butterflies, wasps, and ants.

It's a Good Thing There Are Insects. Allan Fowler. Chicago, IL: Childrens Press, 1990. 32 pp. Identifies many insects and describes their useful activities.

Jellyfish to Insects: Projects with biology. William Hemsley. New York, NY: Gloucester Press, 1991. 32 pp. Provides hands-on science projects.

Kid's Question and Answer Book Three, The. OWL Magazine Staff New York, NY: Grosset & Dunlap, 1990. 80 pp. Gives answers to common questions about animals, plants, insects, and weather.

Life Cycle of a Bee, The. Jill Bailey. New York, NY: Bookwright Press, 1990. 32 pp. Describes the life cycle and feeding process of the bee.

Life Cycle of an Ant. Trevor Terry. New York, NY: Bookwright Press, 1988. 32 pp. Describes the common ant.

**Listening Walk, The (rev. ed.).* Paul Showers. New York, NY: HarperCollins, 1991. 32 pp. Tells a story of a girl and her father who listen as they go for a walk.

Looking at Ants. Dorothy Hinshaw Patent. New York, NY: Holiday House, 1989. 48 pp. Describes the behavior and characteristics of ants.

Magic Mud and Other Great Experiments. Gordon Penrose. New York, NY: Simon & Schuster, 1988. 48 pp. Illustrates basic scientific principles through science activities and demonstrations.

**Monarch Butterfly.* Gail Gibbons. New York, NY: Holiday House, 1989. 32 pp. Describes the life cycle of the butterfly and how to raise one.

Mosquitoes. Dorothy Hinshaw Patent. New York, NY: Holiday House, 1986. 40 pp. Describes the development and habits of mosquitoes and discusses diseases that they carry.

Moth. Barrie Watts. Morristown, NJ: Silver Burdett Press, 1991. 25 pp. Traces the development of the moth (using photos) from the egg to caterpillar, cocoon, and finally the flying insect.

Nature Directory, The: A guide to environmental organizations. Susan D. Lanier-Graham. New York, NY: Walker & Company, 1991. Contains a listing of environmental organizations.

Nature's Great Balancing Act: In our own backyard. E. Jaediker Norsgaard. New York, NY: Dutton, 1990. 64 pp. Explains interrelationships of creatures and plants and the importance of insects in the world.

Nature's Living Lights: Fireflies and other bioluminescent creatures. Alvin Silverstein. Boston, MA: Little, Brown, 1988. 42 pp. Describes bioluminescent insects, plants, and sea animals.

Naturewatch: Exploring nature with your children. Adrienne Katz. Reading, MA: Addison-Wesley Publishing Co., 1986. 128 pp. Offers activities to increase your enjoyment of nature.

**Science Fun with Mud and Dirt.* Rose Wyler. Englewood Cliffs, NJ: Julian Messner, 1986. 48 pp. Provides instructions for indoor and outdoor experiments with soil and rocks.

Shovelful of Earth, A. A. Lorus Johnson Milne. New York, NY: Henry Holt, 1987. 114 pp. Describes different soils and the plants and animals that live in them.

Small Garden Animals. Terry J. Jennings. Chicago, IL: Childrens Press, 1988. 34 pp. Describes insects, spiders, snails, and worms and projects to do with them.

Snails and Slugs. Chris Henwood. New York, NY: Franklin Watts, 1988. 29 pp. Describes snails and slugs and how to keep them.

**Tiny Seed, The.* Eric Carle. Natick, MA: Picture Book Studio, 1987. 32 pp. Describes life cycles of flowering plants.

Tongues and Tasters. Henry Arthur Pluckrose. New York, NY: Franklin Watts, 1990. 32 pp. Explores the sense of taste in the animal kingdom.

We Watch Squirrels. Ada Graham. New York, NY: Dodd, Mead, 1985. 64 pp. Shows and explains the behavior of gray squirrels in the wild.

Wind and Weather. Barbara Taylor. New York, NY: Franklin Watts, 1991. 32 pp. Explains what makes air move, weather forecasting, and air pollution.

Other resources

There are a number of companies and agencies to which you can write for additional information. Ask for a catalogue to learn about the free or inexpensive teaching units, posters, newsletters, and lessons that are available.

AAAS
1333 H Street, N.W.
Washington, DC 20005

Aims Education Foundation
P.O. Box 7766
Fresno, CA 93747

American Geological Institute
Director of Education
National Center for Earth Science Education
4220 King Street
Alexandria, VA 22302

American Institute of Biological Sciences
College of Natural Sciences
University of Northern Iowa
Cedar Falls, IA 50614

American Nature Study Society
Pocono Environmental Education Center
R.D. 1, Box 268
Dingman's Ferry, PA 18328

Heath & Company
Science Newsletter
125 Spring Street
Lexington, MA 02173

National Association of Biology Teachers
11250 Roger Bacon Drive, #19
Reston, VA 22090

Nature Scope
National Wildlife Federation
1400 Sixteenth Street, N.W.
Washington, DC 20036–2266

Outdoor Biology Instructional Strategies
Lawrence Hall of Science
University of California
Berkeley, CA 94720

Butterfly Garden (57–020–6007), Hudson, NH: Delta Education, Inc. A box with see-through sides so that children can see the growth from larvae to painted lady butterfly. Coupon for larvae included.

Critter Emitter (57–031–6568), Hudson, NH: Delta Education, Inc. A set that includes funnel, scoop, tweezers, and other such items so that, through gravity and evaporation, microscopic critters will be separated out of soil or forest litter. Full instructions included.

Fruitflies, Mealworms & Butterflies Mini-Kit (57–740–0095), Hudson, NH: Delta Education, Inc. A mini-kit with teacher's guide for raising three types of insects and studying life cycles. Includes containers, dishes, magnifiers, and coupons for living organisms.

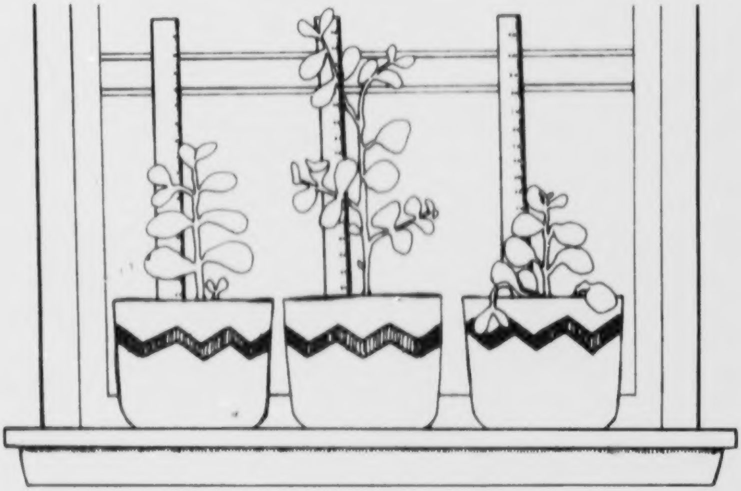
Giant Ant Farm (57–010–2310), Hudson, NH: Delta Education, Inc. An ant farm with coupon for living ants.

4

Exploring botany

Exploring botany can take many forms. It might be that a child who is not especially interested in growing things is nonetheless intrigued with how plants survive in the Arctic or is interested in the strange and unusual plant life of the jungle. Maybe the child wonders about carnivorous plants or the ways bees pollinate plants. Such a child may approach a study of plants by reading about those special areas that are of interest.

Other curious kids will certainly want to make this exploration a hands-on activity and will want to plant seeds, till the soil, and harvest a crop. This type of activity need not require acres of land, but can be achieved even in a school room or an apartment by working in a few containers, strategically placed on a bright windowsill.

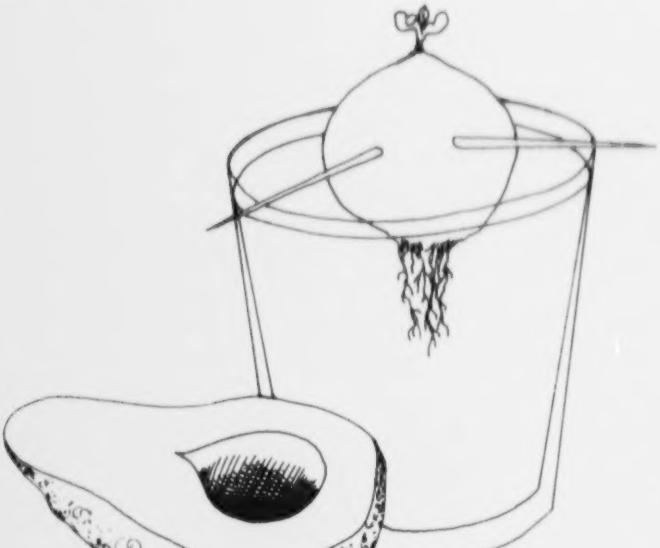


There is a special kind of wonder that is attached to putting a tiny seed into the soil and watching it slowly grow into a plant. Even though the process takes time, the curious child will be fascinated and will learn many lessons in observation and responsibility as he or she cares for the seedling.

Daily measuring of growth and charting changes on a piece of graph paper is a good mathematics application and will help the child see and understand the gradual unfolding process. Other students may want to keep notes on the plant's growth by writing down and dating their observations. Still others may want to make detailed sketches of the growth process.

Sprouting an avocado seed

Purchase an avocado at the grocery store. Cut it in half and remove the large seed from inside. Wash the seed off and encourage the child to examine it. Push three toothpicks firmly into the seed. Then put the seed, pointed end up, into a glass, suspended by the three toothpicks, and with the base of the avocado seed submerged in water. Put it in a sunny window.



Be sure to add water now and then as it evaporates from the glass. Be patient. Soon you will see roots growing down from the seed and a green avocado plant growing up out of the seed.

A similar sprouting process can be observed by conducting the following experiment.

Sprouting lima beans

Buy some dried lima beans. Soak the beans overnight to soften the outer skins. Carefully split one of the beans open and have your curious child examine it with a hand lens. You will be able to see a baby plant curled up at the end of one half of the bean.

Take an old jar and put a piece of blotting paper or several layers of paper toweling onto the bottom of the jar. Put a couple of inches of water into the jar and let it sit while the paper soaks up the water. Then pour the excess water off.

Next, put four of your lima beans on the paper. Wait a few days to see what happens. (You may have to add a few drops of water now and then to keep the paper wet.) Gradually a root and stem will appear on each bean.

If you wish, you can then plant your tiny bean plants out in the garden or in containers. With care, they will grow into big, healthy plants.

Once students are interested in how seeds grow into plants and have learned to observe and note the growth, they may be ready to see what effect different soils and varying light can make on the growth of a plant.

Differing soils

Get three ½-gallon milk cartons. Cut off the tops leaving a 6-inch bottom on each carton. Save the bottoms of the cartons. Label the outside of the cartons #1, #2, and #3. Put about an inch of gravel in the bottom of each carton.

Fill carton #1 with 4 inches of sand, fill carton #2 with 4 inches of rich potting soil, and fill carton #3 with a red clay soil. Choose a plant you'd like to grow and gather or purchase six seeds. Plant two seeds in each of the containers.

Make two graphs for each carton. Label each graph with the carton number and the letter A or B. (A will be for the first plant that sprouts, and B for the second plant that sprouts.) Put number of days along the bottom of each graph. Put ¼ inch marks going up the left side of each graph.

Put the cartons in a sunny window and water them as needed. Observe the cartons each day. On the graphs, indicate on what day the seeds sprouted through the soil. Measure each plant each day and graph its height.

Did the plants sprout faster in one kind of soil or another? Did the plants grow taller and healthier in one kind of soil or another?

Another factor that affects the growth of plants is the amount of sunlight they receive. The following experiment will help prove that light is a factor in plant growth.

Varying amount of sunlight

When you have grown two seeds into plants that appear healthy and that are about the same height, you can experiment with varying light in plant growth.

Place one of your plants in a sunny window and put the other in a closet. Be sure to water each plant regularly.

After a week, what differences do you see between the two plants? What difference do you see after two weeks?

Having done some simple seed experiments, the curious child may want to purchase some seeds and plant them at home or at school. Few things are more enjoyable than growing one's own pumpkin for Halloween. Some companies offer seeds that should yield "giant" pumpkins and encourage you to get an early start by planting the seeds in containers indoors in early spring, then moving them outside when climate conditions permit.

There are a number of other hardy vegetables that will yield a very satisfactory "crop" for the young gardener. Again, if space is a problem, there are a number of tomato plants developed that can be grown in pots on a patio or sunny balcony. These plants will need to be staked, and will grow about 3 feet tall. With care and luck, such plants will yield about 2 dozen tomatoes.

For the child who is more interested in colorful flowers than in vegetables, there are many options, again depending on climate, amount of sun or shade, and space availability. Some examples of colorful flowers include violets and pansies, which can occupy just a small, shady place around a bird bath and beneath a shade tree in a backyard at home, or zinnias and marigolds, which will flourish in full sun in milk cartons in a sunny classroom window. Directions on seed packets or your clerk at your local nursery will give helpful advice.

Not all plants grow from seeds—some grow from spores, such as mushrooms and mosses. Your curious child can learn more about mushrooms by conducting the following experiment.

Making mushroom spore prints

If you live near the woods, you can go for a walk in August and find many different kinds of mushrooms growing. A close look at the underside of the mushroom will reveal whether it is smooth or gilled. Gather two or three of the gilled mushrooms and bring them home with you. (Remember *not* to eat wild mushrooms because some are poisonous.)

Cut the stem near the cap. Lay the cap, gills down, on a sheet of paper. Put a drinking glass over the mushroom like a dome. Wait overnight.

Carefully remove the glass and lift the mushroom cap straight up from the paper. You will find a spore print left on the paper in the shape of the mushroom cap. The spores dropped out of the mushroom gills.

If your curious child is interested in moss and its growth, the following experiment will be enlightening.

Growing a moss garden

You can grow a moss garden in an empty 2-quart pickle jar. Take the lid off, and lay the jar on its side in a shallow box filled with sand.

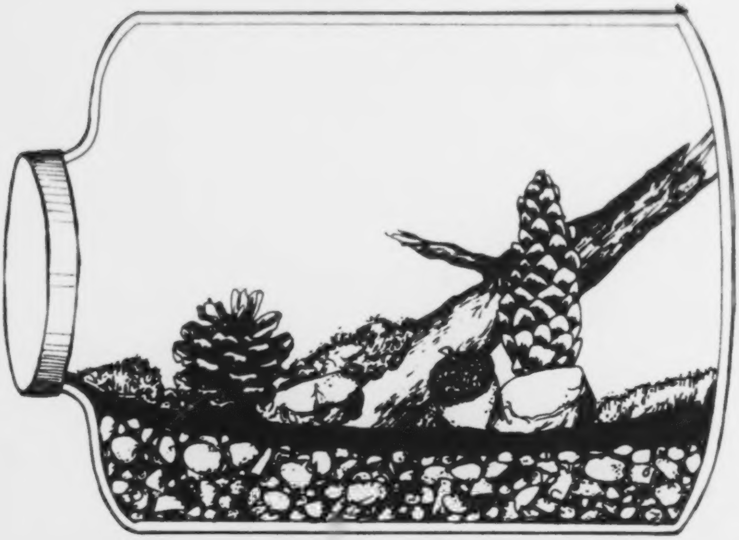
The side of the jar resting on the sand is now the "bottom" of your terrarium. Put a layer of sand and pebbles in the bottom of the jar. Then cover this sandy drainage layer with woodsy soil that you collected from outside. Add a few interesting objects such as a small pinecone, an acorn, some rocks or little pieces of wood or bark.

Next, plant small pieces of moss by pressing them down into your layer of soil. Water the garden and screw the jar lid back on.

Keep your terrarium in a place where it gets only indirect light (not in a sunny windowsill!). Usually moss will grow for several months in the jar without needing more water. Depending on the temperature, you will see moisture collect on the top of the jar and fall like rain. Your mosses will grow spore cases on slender stems that you and your curious child can closely observe through a hand lens.

If the soil seems soggy, you can open the jar for a few hours to let it dry. If it seems dry in the terrarium, add some water.

The resources that follow are designed to help you and your curious child explore whatever aspects of botany are of interest. Remember that some of the resources in other chapters may also prove useful. Some students will want to learn what earthworms do for the soil. Others will be interested in how rocks break down into soils and



why mountains and valleys form. Still others will be interested in plants that live in ponds and oceans. The resources listed after Chapters 3 "Exploring Science in the Backyard," Chapter 6 "Exploring Geology and Paleontology," Chapter 8 "Exploring Geography and Cartography," Chapter 9 "Exploring the Watery World," and Chapter 10 "Exploring the Ocean" might prove helpful.

There are also many interesting craft projects, such as nature mobiles and vegetable and leaf prints, that can be made with plant parts. These resources for such craft projects are listed after Chapter 13 "Exploring Science through Art." Chapter 12 "Exploring science through Writing" includes information on keeping journals, making observations, and writing poetry. This might be of additional interest to the student of botany.

Resource books

**Agave Blooms Just Once.* Gisela Jernigan. Tucson: Harbinger House, 1989. 30 pp. This A-Z illustrated book is filled with verses of plants and animals of the desert.

Amazing Dirt Book, The. Paulette Bourgeois. Reading, MA: Addison-Wesley Publishing Co., 1990. 80 pp. Describes the wonders of dirt and contains several activities with plants and soil.

**Anna's Garden Songs.* Mary W. Steele. New York, NY: Greenwillow Books, 1989. 31 pp. Contains 14 poems about plants in a garden.

Anticipating the Seasons. Jill Bailey. New York, NY: Facts on File, 1988. 61 pp. Explores how animals and plant life adapt to the seasons.

Arctic Tundra. Lynn M. Stone. Vero Beach, FL: Rourke Enterprises, 1989. 48 pp. Explains about plants and animal life of the tundra.

*_Bean and Plant._ Christine Back. Morristown, NJ: Silver Burdett Press, 1985. 24 pp. Follows the development of a bean plant.

Be a Plant Detective. Linda Gamlin. New York, NY: Derrydale Books, 1989. 39 pp. Provides information on finding out about plants.

Botany: 49 more science fair projects. Robert L. Bonnet. Blue Ridge Summit, PA: TAB Books, 1991. 144 pp. Explains experiments in botany.

Cactus. Jason Cooper. Vero Beach, FL: Rourke Enterprises, 1991. 24 pp. Provides an introduction to cacti.

Carnivorous Plants. Cynthia Overbeck. Minneapolis, MN: Lerner Publications Co., 1982. 48 pp. Discusses such plants as the Venus fly trap, sundew, pitcher plant, and bladderwort.

Desert Plants. Susan Reading. New York, NY: Facts on File, 1990. 62 pp. Discusses the specialized plants of the desert.

Deserts. Philip Steele. Mankato, MN: Crestwood House, 1991. 31 pp. Discusses the world's deserts and the plants and animals that grow in them.

Dumb Cane and Daffodils: Poisonous plants in the house and garden. Carol Lerner. New York, NY: Morrow Junior Books, 1990. 32 pp. Explains the characteristics, habitat, and harmful effects of several North American plants.

*_Earth._ Kate Petty. New York, NY: Franklin Watts, 1990. 32 pp. Explains uses of soil as a home for plants and animals and as a building material.

*_Eating the Alphabet: Fruits and vegetables from A to Z._ Lois Eklert. San Diego, CA: Harcourt Brace Jovanovich, 1989. 32 pp. Offers alphabetical examples of various fruits and vegetables.

Everglades. Christine Sotnak Rom. Mankato, MN: Crestwood House, 1988. 47 pp. Describes plants and animals of the Everglades.

First Look at Growing Food. Claire Llewellyn. Milwaukee, WI: Gareth Stevens Pub., 1991. 32 pp. Presents an introduction to gardening and farming.

Flowering Plants. Wendy Madgwick. Austin, TX: Steck-Vaughn Library, 1990. 47 pp. Surveys flowering plants and discusses pollination, flowers, seeds, and fruits.

*_Flowers._ Terry J. Jennings. Chicago, IL: Childrens Press, 1989. 34 pp. Contains simple experiments involving plants and flowers.

Flowers for Everyone. Dorothy Hinshaw Patent. New York, NY: Cobblehill Books, 1990. 64 pp. Discusses the growth and cultivation of flowers.

Flowers, Fruits, Seeds. Jerome Wexler. New York, NY: Prentice-Hall Books for Young Readers, 1987. 32 pp. Shows, in photographs, the different cycles from flower to fruit to seed to flower.

Flowers, Trees and Other Plants. Angela Royston. New York, NY: Warwick Press, 1991. 40 pp. Includes projects and activities for studying growing things.

Forest, The. Isidro Sanchez and Carme Peris. New York, NY: Barron's, 1991. 32 pp. Explores a trip into the forest to learn about trees, animals, plants, and insects.

Forest Fire. Christopher Lampton. Brookfield, CT: Millbrook Press, 1991. 64 pp. Discusses forest fires and how they are in some ways beneficial.

Four Seasons, The. Ruth Thomson. Milwaukee, WI: Gareth Stevens Pub., 1985. 48 pp. Describes the four seasons and their effect on plants and animals.

From Seed to Plant. Gail Gibbons. New York, NY: Holiday House, 1991. 32 pp. Explores how seeds grow into plants.

Frost: Causes and effects. Philip Steele. New York, NY: Franklin Watts, 1991. 32 pp. Explains how frost forms and its effects on humans as well as plants and animals.

Fun with Fruits and Vegetables. Patricia Lief. Carthage, IL: Good Apple, 1991. 154 pp. An activity book involving fruits and vegetables.

Fun with Growing Things. Joan Eckstein and Joyce Gleit. New York, NY: Avon Books, 1991. 135 pp. Contains step-by-step instructions for growing plants and projects such as leaf prints.

* *Garden Alphabet, A.* Isabel Wilner. New York, NY: Dutton, 1991. 32 pp. Contains rhymes about gardens.

Garden Tools & Gadgets You Can Make. Percy W. Blandford. Blue Ridge Summit, PA: TAB Books, 1989. 244 pp. Provides instructions for making gardening tools.

Get Growing: Exciting indoor plant projects for kids. Lois Walker. New York, NY: John Wiley & Sons, 1991. 101 pp. Contains eleven indoor gardening projects and includes ideas for cooking and handicrafts.

Grasslands. David Lambert. Morristown, NJ: Silver Burdett Press, 1988. 48 pp. Explores plants and animal life of the grasslands.

Greening the City Streets: The story of community gardens. Barbara A. Huff. Boston, MA: Houghton Mifflin, 1990. 61 pp. Explores the urban garden movement through photos.

**Growing Colors.* Bruce McMillan. New York, NY: Lothrop, Lee & Shepard Books, 1988. 32 pp. Contains photos of various fruits and vegetables showing the colors in nature.

Growing Plants. Barbara Taylor. New York, NY: Warwick Press, 1991. 40 pp. Contains simple experiments to demonstrate what affects plant growth.

**Grow It for Fun.* Denny Robson and Vanessa Bailey. New York, NY: Gloucester Press, 1991. 32 pp. Provides an introduction to gardening with suggestions for simple activities.

Harvesters. Irene M. Frank and David M. Brownstone. New York, NY: Facts on File, 1987. 139 pp. Discusses various occupations of collecting and cultivating food such as fishing, beekeeping, and farming.

Hidden Life of the Meadow, The. David M. Schwartz. New York, NY: Crown Publishers, 1988. 36 pp. Examines plants and animals of the meadow.

Hidden Stories in Plants: Unusual and easy-to-tell stories from around the world, together with creative things to do while telling them. Anne Pellowski. New York, NY: Macmillan, 1990. 93 pp. Contains myths, folklore, and other stories with directions for making ornaments, toys, and musical instruments from plants.

**How Do Apples Grow?* Betsy Maestro. New York, NY: HarperCollins, 1992. 32 pp. Shows life cycle of an apple tree.

How Plants Grow. Stephen Parker. New York, NY: Warwick Press, 1985. 32 pp. Discusses various kinds of plants and how humans and plants depend upon each other.

Insects and Flowers. Hidetomo Oda. Milwaukee, MN: Raintree Childrens Books, 1986. 32 pp. Discusses plant nectar and pollination.

Kid's First Book of Gardening, A. Derek Fell. Philadelphia, PA: Running Press, 1989. 96 pp. Contains information on soils and easy-to-grow flowers and vegetables in the yard and in containers.

Kitchen Fun: Teaches children to cook successfully. Louise Price Bell. New York, NY: Derrydale Books (dist. by Crown Publishers), 1988. 26 pp. Contains a collection of easy recipes for candy, cakes, cookies, salads, and vegetables.

**Life Cycle of a Sunflower, The.* Philip Parker. New York, NY: Bookwright Press, 1988. 32 pp. Describes sunflowers and includes simple projects.

Life in the Polar Lands. Monica Byles. New York, NY: Franklin Watts, 1990. 31 pp. Tells how humans, plants, and animals can survive at the North and South Poles.

Linnea's Windowsill Garden. Christina Bjork and Lena Anderson. New York, NY: Farrar, Straus, & Giroux, 1988. 59 pp. Tells how to create a home garden.

Living House, The. Nigel S. Hester. New York, NY: Franklin Watts, 1991. 32 pp. Shows how a house can become a home for plants as well as for insects, animals, and birds.

Moonseed and Mistletoe: A book of poisonous wild plants. Carol Lerner. New York, NY: Morrow Junior Books, 1988. 32 pp. Discusses how some plants irritate the skin or cause illness when eaten.

More than just a Flower Garden. Dwight Kuhn. Morristown, NJ: Silver Burdett Press, 1990. 40 pp. Contains tips for starting a garden.

Morning Glories. Sylvia A. Johnson. Minneapolis, MN: Lerner Publications Co., 1985. 48 pp. Examines the stages of development of morning glories.

Mountains. Lynn M. Stone. Vero Beach, FL: Rourke Enterprises, 1989. 48 pp. Describes plants and animals of the mountains.

Mushrooms. Jason Cooper. Vero Beach, FL: Rourke Enterprises, 1991. 24 pp. Provides an introduction to mushrooms.

My First Green Book. Angela Wilkes. New York, NY: Alfred A. Knopf, 1991. 48 pp. Contains environmental activities and projects in such areas as water pollution, recycling, and wildlife gardens.

Natural Materials. Erica Burt. Vero Beach, FL: Rourke Enterprises, 1990. 32 pp. Explains how to make objects from twigs, flowers, vegetables, pebbles, shells, feathers, and other things of nature.

Nature Crafts: Outdoor magic using natural materials for creative crafts. Sabine Lohf. Chicago, IL: Childrens Press, 1990. 44 pp. Gives directions for crafts using flowers, leaves, vegetables, and other natural items.

Nature Projects for Young Scientists. Kenneth G. Raines. New York, NY: Franklin Watts, 1989. 142 pp. Contains nature projects and experiments involving plants and animals.

* *Peter Rabbit's Gardening Book.* Sarah Garland. London, Eng.: F. Warne, 1983. 48 pp. Gives instructions for growing many of the flowers, fruits, and vegetables mentioned in Beatrix Potter's stories.

Plant. David Burnie. New York, NY: Alfred A. Knopf, 1989. 63 pp. Describes the world of plants through photos.

Plant Ecology. Jennifer Cochrane. New York, NY: Bookwright Press, 1987. 47 pp. Discusses conservation of natural resources.

Plant Families. Carol Lerner. New York, NY: Morrow Junior Books, 1989. 32 pp. Contains simple descriptions of 12 families of North American flowering plants.

Plant Partnerships. Joyce Pope. New York, NY: Facts on File, 1990. 62 pp. Contains information on plants that depend upon animals or other plants for habitat or survival.

Plants and Seeds. John Stidworthy. New York, NY: Gloucester Press, 1990. 32 pp. Explains about the ways plants reproduce and assimilate nutrients by use of informative text and microscopic photos.

Plants of the Tropics. Susan Reading. New York, NY: Facts on File, 1990. 62 pp. Shows how plants of the tropics adapt.

Plants without Seeds. Helen J. Challand. Chicago, IL: Childrens Press, 1986. 45 pp. Discusses algae, fungi, lichen, mosses, and fern.

Potato. Barrie Watts. Morristown, NJ: Silver Burdett Press, 1988. 25 pp. Describes how a potato develops.

Potatoes. Sylvia A. Johnson. Minneapolis, MN: Lerner Publications Co., 1984. 47 pp. Describes the development of a potato.

Practical Plants. Joyce Pope. New York, NY: Facts on File, 1990. 62 pp. Examines the many uses of plants.

Prairies. Lynn M. Stone. Vero Beach, FL: Rourke Enterprises, 1989. 47 pp. Describes plants and animals of the prairies.

•*Pumpkin, Pumpkin.* Jeanne Titherington. New York, NY: Greenwillow Books, 1986. 23 pp. Tells a story of how Jamie plants, grows, carves, and saves seeds from pumpkins.

Poisonous Plants. Suzanne M. Coil. New York, NY: Franklin Watts, 1991. 62 pp. Identifies poisonous plants that might be found in the home, garden, and in the wild.

Rainforests. Rodney Aldis. New York, NY: Dillon Press, 1991. 45 pp. Discusses the plants and animals of the rainforest.

Reason for a Flower, The. Ruth Heller. New York, NY: Grosset & Dunlap, 1983. 42 pp. Explains how to plant flowers and their reproduction.

Roses Red, Violets Blue: Why Flowers Have Colors. Sylvia A. Johnson. Minneapolis, MN: Lerner Publications Co., 1991. 64 pp. Examines the nature and function of flower colors.

•*Rosy's Garden: A child's keepsake of flowers.* Elizabeth Laird. New York, NY: Philomel Books, 1990. 48 pp. Tells a story about how, on a visit to grandma's, a child gathers seeds, makes potpourri, and presses flowers.

•*Science Book of Things that Grow.* Neil Ardley. San Diego, CA: Harcourt Brace Jovanovich, 1991. 29 pp. Contains many simple plant experiments.

Science for Kids: 39 easy plant biology experiments. Robert W. Wood. Blue Ridge Summit, PA: TAB Books, 1991. 123 pp. Contains information on 39 plant experiments.

Science Projects for Young People. George Barr. New York, NY: Dover Publications, 1986. 153 pp. Contains several topics for science research projects, including plants.

Seeds and Seedlings. Terry J. Jennings. Chicago, IL: Childrens Press, 1989. 34 pp. Includes study questions, activities, and experiments about seeds and different plants.

Seeds to Plants: Projects with biology. Jeffrey Bates. New York, NY: Gloucester Press, 1991. 32 pp. Explores how seeds grow into plants.

Strawberry. Jennifer Coldrey. Morristown, NJ: Silver Burdett Press, 1989. 25 pp. Offers, in addition to text, photos and drawings of strawberries.

Sugar: All plants make sugar, but only two do so in great quantity. Jacqueline Dineen. Hillside, NJ: Enslow Pub., 1988. 31 pp. Discusses sugar beets and cane.

Tiger Lilies and other Beastly Plants. Elizabeth Ring. New York, NY: Walker and Company, 1985. 32 pp. Contains full-color illustrations of many interesting plants.

* *Vegetable Garden.* Douglas Florian. San Diego: Harcourt Brace Jovanovich, 1992. 32 pp. Shows a family planting and harvesting.

Vegetables. Susan Wake. Minneapolis, MN: Carolrhoda Books, 1990. 32 pp. Discusses different vegetables and gives some easy recipes using them.

Vegetables and Oils. Jacqueline Dineen. Hillside, NJ: Enslow Pub., 1988. 31 pp. Contains information on vegetables.

* *Very Young Gardener, A.* Jill Krementz. New York, NY: Dial Books for Young Readers, 1991. 38 pp. Provides a tale of a six-year-old who grows flowers and vegetables, looks at plants in the woods, and visits a botanical garden.

* *Walk in the Woods, A.* Caroline Arnold. Morristown, NJ: Silver Burdett Press, 1990. 30 pp. Describes plants, animals, and seasons of the year as seen in the woods.

Where Butterflies Grow. Joanne Ryder. New York, NY: Dutton, 1989. 32 pp. Gives tips to attract butterflies to your garden.

Where Food Comes From. Dorothy Hinshaw Patent. New York, NY: Holiday House, 1991. 40 pp. Shows how sun, earth, air, and water combine to help plants grow.

Why Is the Grass Green? Chris Arvetis. Chicago, IL: Childrens Press, 1985. 32 pp. Explains the process of photosynthesis.

Wonderful Woods, The. Rose Wyler. Englewood Cliffs, NJ: Julian Messner, 1990. 32 pp. Describes plants and animals found in the forest and suggests activities.

Wondrous Plant & Earth Experiments. Q. L. Pearce. New York, NY: T. Doherty Associates, Inc., 1989. 58 pp. Offers a plethora of science experiments.

Worm's Eye View. Kipchak Johnson. Brookfield, CT: Millbrook Press, 1991. 40 pp. Describes ways to attract wildlife to your backyard and discusses the role of wild plants in ecology.

Other resources

The following magazines may be of interest as you explore plants and gardening: *Better Homes and Gardens; California; Chatelaine; Country Journal; Flower & Garden Magazine; Horticulture; The Magazine of American Gardening; Nature Canada; Organic Gardening;* and *Sunset Magazine.*

Carrot Seed, The. Ruth Krauss. Ancramdale, NY: Live Oak Media, 1990. 1 book, 23 pp.; 1 sound cassette, 4 minutes. Introduces a popular story to young children about growing a carrot.

Flowers, Plants and Trees. Rima Firrone. Penguin Productions: Distributed by Prism Entertainment, 1987. 1 cassette, 30 minutes. A video encyclopedia that answers questions children ask about flowers, plants, and trees.

Hydroponic Greenhouse (330–GS1). San Diego, CA: Creative Learning Systems, Inc. Small, plastic greenhouse comes with nutrient and an illustrated manual.

Hydroponic Greenhouse (57–070–1964). Hudson, NH: Delta Education, Inc. Tabletop green house with nutrient mix included.

Mushroom Growing Kit (57–110–0725). Hudson, NH: Delta Education, Inc. Everything you need to grow edible mushrooms is included. Can only be shipped October to June.

Soil Test Kit (57–110–0582). Hudson, NH: Delta Education, Inc. Allows you to test soil conditions and contains information on how to improve soil for better growth.

Windowsill Greenhouse (57–070–2151). Hudson, NH: Delta Education, Inc. These narrow trays and bases, in which to grow plants, are designed to fit in a windowsill.

5

Exploring ethology

Ethology is the study of animal behaviors. Interested children and adults can find numerous opportunities to observe birds and animals and to watch what they do. Children can sometimes observe birds and small animals in their own backyards. Other observations may require a teacher or another adult to accompany a child or group of children for a walk in the woods, to a park, or to take a visit to a zoo where more exotic creatures can be found.

Many adults and children take pleasure in observing birds. Scientists estimate there are about a 100 billion birds in the world. So whether you live in the city, the suburbs, or the country, you will encounter them.

Some children are fascinated with these wonderful creatures, and their observational skills will sharpen as they look at the colors, notice different kinds of beaks and feet, and listen to the variety of bird songs and calls.

If you have a backyard or courtyard at home or a nature area at school, there are many projects that you can undertake to attract birds to visit.

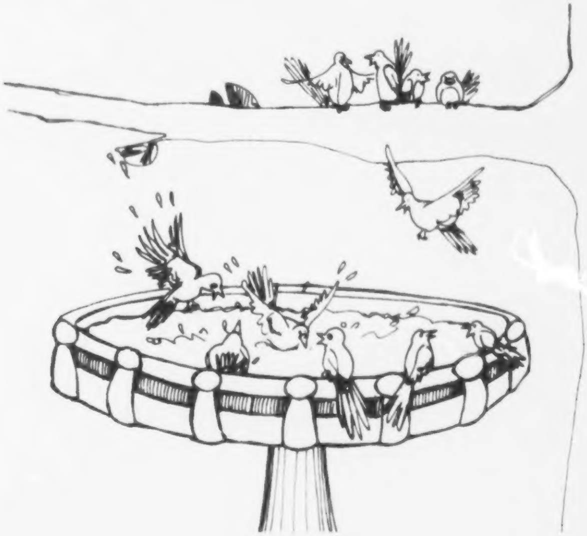
Adding a birdbath

Putting a birdbath in your backyard or in a nature area on the school grounds can provide hours of enjoyment as you and curious children observe the birds that collect there to drink and bathe.

Many commercial birdbaths are available. You can make one by putting a shallow basin in a spot where birds come. You will need to make it secure so that it does not wobble or tip over. You might even put a clean stone in the middle of the bath where birds might stand while drinking.

With all bird feeders or baths, you need to be sure that they are placed where cats and other predators will not easily be able to hide and attack the birds.

Having a birdbath placed up on a pedestal is safer than having one on the ground. Placing the birdbath near a tree allows birds to perch and look about for danger before they visit the birdbath.



Birds eat many different kinds of foods. Ducks, gulls, terns, and herons eat fish, frogs, water plants, tiny shellfish, and insects that they find along shores, beaches, marshes, and lakes. Bobwhites, meadowlarks, and robins search in the grass and leaves for their food. Raptors, such as hawks and owls, eat rodents and other small animals. Fly catchers and swallows catch their meals as they fly. Some birds prefer beetles and caterpillars, while others prefer seeds.

Depending on where you live and what kinds of birds you are trying to attract, you can put up a bird feeder and fill it with appropriate mixes of seeds. Many feeders are available for purchase, although you might want to make one of your own.

Some feeders are simply flat trays. Another type of feeder looks like a house with a hinged roof that lifts for filling, a glass front, and a porch in front that sticks out where the birds perch while eating. Many feeders are long slender tubes with perches sticking out from the tube by small feeding holes and with a base tray where other birds can stand and eat.

While these feeders are best placed in a backyard or in a nature area of the school grounds, they can also be placed outside apartment windows or on apartment building rooftops.

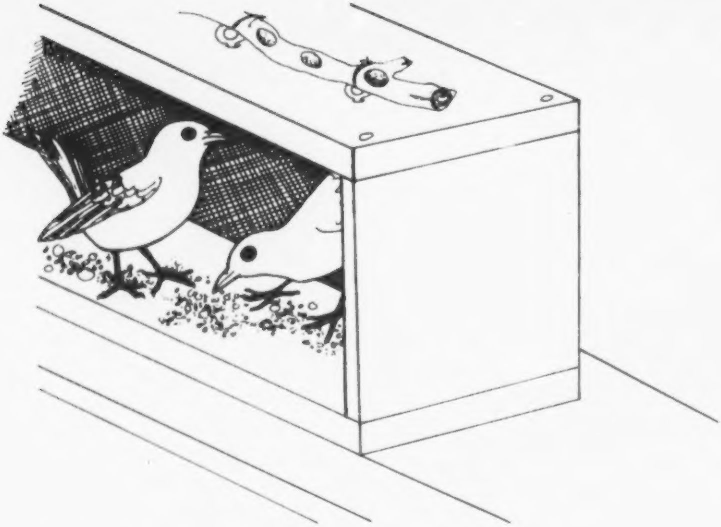
Making a windowsill bird feeder

You can use a windowsill for a bird feeder. By just sprinkling seeds on the sill, you will attract small birds.

You may want to attach a small, four-sided, wooden box to your sill. A good size is 20 inches wide by 10 inches deep. Leave your box open in back and front so that you can see the birds through your window and so that the birds can easily enter. Sprinkle seeds on the floor of the box.

As a special winter treat, you may want to suspend a suet feeder inside the box. Drill holes into a short, small log or piece of wood. Fill the holes with peanut butter or suet. Screw an eye into the top of the log and tie a short piece of twine to it. Then hang the wood from another eye that is screwed into the top of your feeder box.

Feeders sometimes attract more than birds, and depending on the placement of a feeder, you may find yourself battling squirrels. Squirrels are especially fond of the sunflower seeds that are found in many birdseed mixes. They are willing to toss millet and other seeds to the ground in search of the one special seed they like. Squirrels have no patience with the small openings through which birds are able to take seeds. So they "enlarge" these openings by gnawing through wood and plastic and destroying the feeder itself.



The best solution to prevent your bird feeder from being vandalized by squirrels is to buy one with a baffle (or dome) suspended over the top. Then when you place your feeder high in the air, the squirrel may jump on the dome but probably will not be able to move from there to the bird feeder itself.

Birds' nests are wonderfully constructed, and you and your curious child or your class of students may be lucky enough to find one that the wind has blown to the ground or that came down with a dead tree. Do not take nests that are still up in healthy trees because some birds use their nests more than once.

Other birds prefer nest boxes, and you and your students or your curious child may want to build one of these. It could be placed in a tree in the backyard or in a school nature area.

Constructing a nest box

Although you can use any kind of wood, white pine or redwood, about ¾ inch or 1 inch thick is best for a nest box. Use medium screws, about 1½ inches long to join the pieces of your next box together. It is also a good idea to use a brown stain on your wood and let it dry thoroughly before you put the pieces together. This stain will protect the nest box from the weather. The directions below are for a bluebird nest box.

The back of your nest box, which you will nail to a post or tree about 8 feet above the ground, should be 5½ inches wide by 15 inches tall. The bottom should measure 4 inches by 4 inches. The front should be 5½ inches wide by 9 inches high. The front also needs to have a 1½ inch diameter hole drilled in the middle of it, 1½ inches from the top.

The two sides should be 4 inches wide and square across the bottom. But the tops should be cut on a slight slant so that the sides measure 9½ inches at the back of the side but only 9 inches at the front end of the side.

Once you have screwed together the back, two sides, and bottom on the nest box, you are ready to put on the top. The top piece of wood should measure 5½ inches across and be 6½ inches long. Set it in place, on the slight slant, and use a small hinge to affix it to the back, about 3 inches from the top of the back board.

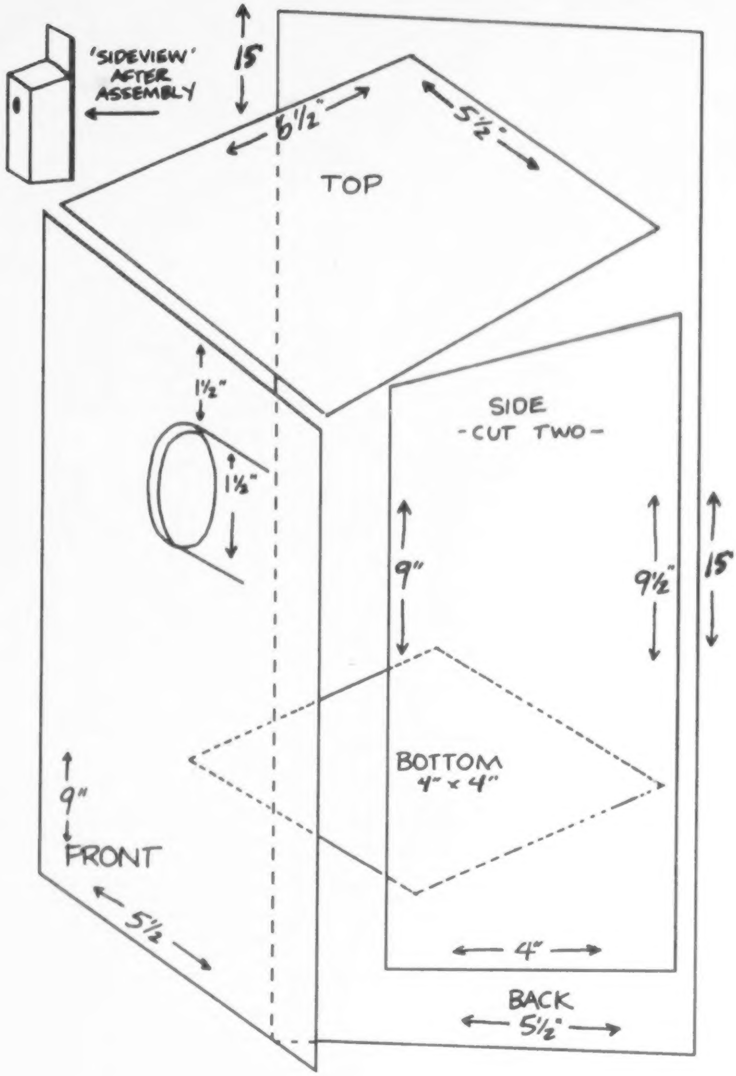
Use a hook and eye, as a means to close the lid tightly. Screw the eye into the top of the nest box and affix the hook to one of the sides.

This hinged top will allow you and your curious child to clean out the nest box after the young birds have flown, so that the bluebirds will have a clean place to start a new nest next year.

As you learn more about birds, questions will certainly arise. These questions may center around the migration of birds, their ability to fly, or their development from eggs. The listed resources at the end of the chapter (as well as some of the resources listed after Chapter 3 "Exploring Science in the Backyards") may be of help to you as you follow up on these interests that emerge.

You and your curious child may simply enjoy listening to birds and watching them in your backyard or in a neighborhood park. Perhaps you'll decide to study them in depth so that you can identify them. You may set up feeding stations, nest boxes, or birdbaths to attract them. Perhaps you'll even decide on a canary or other type of bird for a pet. Whatever you choose, you will derive pleasure from your exploration of birds.

You may also be fortunate enough to observe small animals in your backyards, in parks, or on school field trips. In some neighborhoods, squirrels are frequent visitors. If you live in the suburbs or country, you may be visited by raccoons, deer, chipmunks, or coyotes. Perhaps somewhere along a highway in your area is a field that has become a prairie dog community. Whatever resources you have, make the most of them. You can look at tracks as well as observe the animals.


'SIDEVIEW' AFTER ASSEMBLY
15
6½"
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TOP
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4" x 4"
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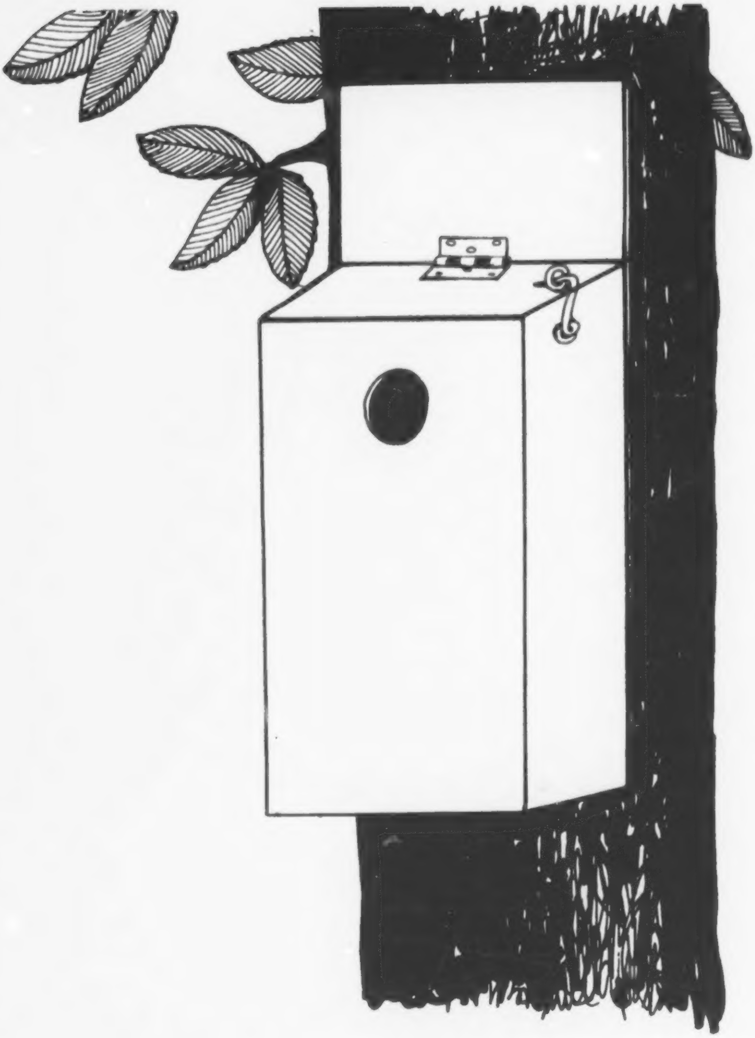


An outing to a zoo can be another exciting way to explore science and nature! The curious child or a class of students will no doubt come away with many questions that can lead to further research and additional activities. In most zoos, there is so much to see that it is hard to take everything in, especially on a first visit. By having a few key things to look for before you go, you'll be more thorough in your visit. Don't forget to consult the explanatory signs on your walk through the zoo for a further explanation of each animal and its habitat.

Reading zoo treasure hunt signs

In most zoos there are explanatory signs and symbols. Take the time to study one of these signs carefully and point out the symbol that designates an endangered species. Explain what this means. Then, as you walk through the zoo, have the child or class of students be on the lookout for the endangered species markings. How many can you find?

It can be much like a treasure hunt because these few remaining creatures are indeed valuable.

Other activities can come from a trip to the zoo, like the following experiment that the child or class can conduct during and after the zoo visit.

Examining a world map of animals

As a follow-up to a zoo trip, have the child or your class list animals that he or she saw at the zoo that were of particular interest. Use reference books to learn where these animals live throughout the world.

Find a large world map. Have the child draw the zoo animals of interest or find pictures of these animals in old magazines and cut them out. Then place the animals on the world map to show them in their natural habitat. (Some animals may be found in more than one place.)

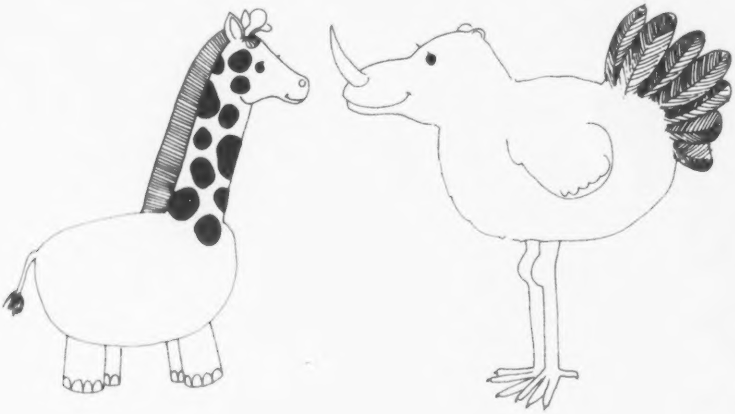
The finished map can make an interesting wall display in a classroom or the child's room.

There are so many wonderful animals in the zoo that it is often hard to choose a favorite. Some are so unusual that it is difficult to believe your eyes, even when you're looking at them. Another follow-up activity that might prove to be fun is explained in the following activity.

Drawing a combination animal

Have members of the class or a child draw a "combination animal" in its habitat. For this purpose you might make available crayons, colored pencils, magic markers, and other such mediums.

A combination animal has the characteristics of two zoo animals. For example, a hippogiraffe might have the head and neck of a giraffe on the body of a hippopotamus! Other possibilities include: the chimpanzebra, the oranguphant, and the rhinostrich. Imagination is the only limit!



While going through the zoo, the class of students or the curious child may notice any one of a number of different features of the various animals. Sometimes it is interesting to concentrate on a single feature, such as the animals' feet. Help the child to notice the enormous size of an elephant's foot, the look of an ostrich foot, the size of the tigers' paws as they pace back and forth, the feet of a penguin as it waddles to the edge and plunges into the water, and other animals' feet on your trip through the zoo.

This should stimulate some conversation in class or at home about the way the animals interact with their environment. For example, a polar bear has hairs on his feet and often weaves back and forth from foot to foot while it is standing so that its feet do not stick to the ice.

If you, a neighbor, or friend have a pet, you might follow up your observations of the feet of animals by making a cast of a foot print.

Impressing footprints

Mix up plaster of paris according to the directions on the box. Cut off the top of a milk carton, so that the carton stands about 3 inches high. Pour two inches of plaster of paris into the carton, and let it partially harden.

Rub a little Vasoline on the paw of a friendly dog you know. Place the dog's paw into the plaster of paris, making a good impression. (The vasoline coating will help you to easily wipe the paw clean.) Allow the print to harden.

The next time you are on a hike in the woods, check for footprints. Can you make a guess from the prints as to what creature made it?

Some classrooms have class pets, and some do not. Some children are in a position to keep pets in their house or apartment, and others are not. Besides the pleasure and companionship that a pet provides, the care of one also teaches the child responsibility. Even if space in the classroom, apartment restrictions, allergies, frequent traveling, and other excuses prevent you from keeping large pets at home or school, it might be possible to set up a miniature zoo.

Setting up a miniature zoo

To keep a miniature zoo, you need a corner of a room with two tables near a window that will provide air and light. In good weather, the screened window should be kept open. During cold weather, a lamp might be useful to provide warmth and light. Remember to provide shady areas in the containers for the animals during spells of hot weather.

The tables need to have tops that can be kept wiped clean. One table should have shelves above or below it where food supplies can be kept. It also needs a clear work space for mixing food, cleaning cages, and other duties.

The remainder of the work table and the surface of the other table can hold large glass jars; a dish pan, plastic bowl, or tub with gravel and water; small aquariums that have been turned into terrariums by adding earth; plants with a screened top; and even cardboard boxes that have clear plastic across one side so that you can easily see in. These various containers can house such creatures as: crayfish, tadpoles, a small snake, horned toad, crickets, meal worms, and a lizard.

Before undertaking the setting up and maintenance of even a miniature zoo, the child or class needs to know that it takes a lot of time to feed the creatures, give them fresh water, and to clean their cages every week.

Studying the behaviors of birds and animals at school, at home, in your backyard, in a park, at the zoo, or wherever you can see them, can be a lot of fun and provides interesting topics for further research. In addition to the following resources listed to aid you in your exploration, you might also want to consult Chapter 9 "Exploring the Watery World," and Chapter 10, "Exploring the Ocean."

Resource books

**ABC Zoo.* Jean Warren. Everett, WA: Warren Publishing House, 1991. 45 pp. Tells the alphabet by using zoo animals for each letter.

All About Baby Animals. Michael Chinery. New York, NY: Doubleday, 1990. 45 pp. Explores the physical characteristics and habits of more than 30 baby mammals, birds, fish, and insects.

Alligators and Crocodiles. John Bonnet Wexo. Mankato, MN: Creative Education, 1989. 24 pp. Looks at the physical characteristics, behaviors, and different kinds of alligators and crocodiles.

Amazing Birds. Alexandra Parsons. New York, NY: Alfred A. Knopf, 1990. 29 pp. Introduces several unusual birds such as the vulture and hummingbird.

Amazing Egg Book, The. Margaret Griffin. Reading, MA: Addison-Wesley Publishing Co., 1989. 64 pp. Explains the functions of eggs.

Amazing Tropical Birds. Gerald Legg. New York, NY: Alfred A. Knopf, 1991. 29 pp. Provides text and photos of tropical birds.

Animal Migration. Nancy J. Nielsen. New York, NY: Franklin Watts, 1991. 63 pp. Shows the migratory patterns of birds, fish, and mammals.

Animals and the New Zoos. Patricia Curtis. New York, NY: Dutton, 1991. 60 pp. Explains how zoos are trying to exhibit animals in environments resembling natural habitats.

**Animals Can Be Special Friends.* Dorothy Chlad. Chicago, IL: Childrens Press, 1985. 31 pp. Explains rules for the treatment and care of pets, wild animals, and zoo animals.

Animals in Winter. Catherine de Sairigne. Ossining, NY: Young Discovery Library, 1988. 35 pp. Provides a simple introduction to birds, bats, bears, and frogs and how they live in winter.

Animals Keeping Clean. Jane Burton. New York, NY: Random House, 1989. 24 pp. Shows how animals use claws and beaks to keep themselves clean.

*_Animals Keeping Warm._ Jane Burton. New York, NY: Random House, 1989. 24 pp. Explains how fur and feathers keep animals warm.

Animals Talking. Jane Burton. Brookfield, CT: Newington Press, 1991. 24 pp. Discusses how animals, including birds, communicate.

Any Bear: A polar cub grows up at the zoo. Ginny Johnston and Judy Cutchins. New York, NY: Morrow Junior Books, 1985. 62 pp. Shows the first year in the life of a polar bear cub at the Atlanta Zoo.

Apes, The. John Bonnett Wexo. Mankato, MN: Creative Education, 1990. 24 pp. Provides a physical description and discusses the habitat and behaviors of gorillas, orangutans, and chimpanzees.

Apple Tree. Peter Parnall. New York, NY: MacMillan, 1987. 32 pp. Shows interactions of a tree with insects, birds, and other animals.

Archaeopteryx: The first bird. Elizabeth J. Sandell. Naples, FL: Bancroft-Sage Publishers, 1989. 31 pp. Describes the work of paleontologists who reconstruct a fossil.

*_Baby Animals._ John Bonnett Wexo. Mankato, MN: Creative Education, 1990. 24 pp. Introduces baby zoo animals.

Bears. John Bonnett Wexo. Mankato, MN: Creative Education, 1989. 24 pp. Discusses the physical characteristics of bears, different species, and their relationship to humans.

Big Cats. John Bonnett Wexo. Mankato, MN: Creative Education, 1990. 24 pp. Gives the physical characteristics and describes the habitat and behaviors of lions, tigers, leopards, and cheetahs.

Big Golden Book of Backyard Birds, The. Kathleen N. Daly. Racine, WI: Western Publishing Co., 1990. 61 pp. Provides an introduction to backyard birds.

Bird. David Burnie. New York, NY: Alfred A. Knopf (dist. by Random House), 1988. 63 pp. Shows a bird's body construction, feathers, flight, beaks, feet, and other noteworthy parts.

*_Bird Alphabet Book, The._ Jerry Pallotta. Watertown, MA: Charlesbridge Pub., 1991. 32 pp. Shows a bird for each letter of the alphabet.

Bird-Eating Spiders. Louise Martin. Vero Beach, FL: Rourke Enterprises, 1988. 23 pp. Shows the world's largest spiders that nest in trees and feed on birds and small animals.

Bird Feeder Book, The: An easy guide to attracting, identifying, and understanding your feeder birds. Donald and Lillian Stokes. Boston, MA: Little, Brown, 1987. 90 pp. Discusses birds commonly found at feeders.

Bird Migration. Liz Oram. Austin, TX: Steck-Vaughn Library, 1992. 49 pp. Discusses the migration patterns of various birds.

Birds. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1990. 48 pp. Gives basic information on birds, their habitats, and behaviors.

Birds. Christine Butterworth. Morristown, NJ: Silver Burdett Press, 1988. 32 pp. Discusses such birds as canaries, bowerbirds, and hummingbirds.

Birds. Terry J. Jennings. Chicago, IL: Childrens Press, 1989. 34 pp. Provides an introduction to birds with activities and suggested experiments.

Birds. Wendy Meadway. New York, NY: Bookwright Press, 1990. 32 pp. Provides an introduction to birds.

Birds. Dean Morris. Milwaukee, MN: Raintree Childrens Books, 1988. 46 pp. Discusses birds, their behaviors, migrations, food gathering, and nest building.

Birds. Philip Steele. Mankato, MN: Crestwood House, 1991. 32 pp. Provides general facts about birds.

Birds: A guide to familiar American birds. Herbert S. Zim and Ira N. Gabrielson. Racine, WI: Western Publishing Co., 1991. 160 pp. Helps in the identification of birds.

Birds and Mammals. Lionel Bender. New York, NY: Gloucester Press, 1988. 36 pp. Provides an introduction to birds and mammals.

Birds Do the Strangest Things. Leonora Hornblow and Arthur Hornblow. New York, NY: Random House, 1991. 63 pp. Shows 22 birds with unusual habits or characteristics.

**Bird's Nest.* Barrie Watts. Morristown, NJ: Silver Burdett Press, 1987. 24 pp. Tells the story of the blue titmouse family through photos, drawings, and text.

Birds of Antarctica: The Adelie penguin. Jennifer Owings Dewey. Boston, MA: Little, Brown, 1989. 48 pp. Discusses the Adelie penguin.

Birds of Antarctica: The wandering albatross. Jennifer Owings Dewey. Boston, MA: Little, Brown, 1989. 47 pp. Presents a year in the life of an albatross.

Birds of Prey. Jill Bailey. New York, NY: Facts on File, 1988. 61 pp. Discusses eagles, hawks, owls, and vultures.

Birds of Prey. Kate Petty. New York, NY: Gloucester Press, 1987. 31 pp. Discusses birds of prey.

Birds—Right before Your Eyes. John R. Weissinger. Hillside, NJ: Enslow Pub. 1988. 64 pp. Gives information and contains drawings of various American birds.

Birds: The aerial hunters. Marilyn Bramwell. New York, NY: Facts on File, 1989. 96 pp. Discusses predatory and insectivorous birds.

Birds: The plant and seed eaters. Jill Bailey and Steve Parker. New York, NY: Facts on File, 1989. 96 pp. Gives a brief description of various birds that eat plants and seeds.

Birds: The waterbirds. Robin Kerrod. New York, NY: Facts on File, 1989. 96 pp. Gives a brief description of waterfowl.

Bird Watch: A book of poetry. Jane Yolen. New York, NY: Philomel Books, 1990. 36 pp. Contains poems about birds.

Birdwatch: A young person's introduction to birding. Mary MacPherson. Toronto, Canada: Summerhill Press, 1988. 136 pp. Introduces the reader to the world of bird watching.

Bird World. Struan Reid. Brookfield, CT: Millbrook Press, 1991. 64 pp. Contains an introductory survey of birds.

Blue-Footed Booby: Bird of the Galapagos. Adapted by Nicholas Millhouse. New York, NY: Walker & Company, 1986. 32 pp. Describes the life cycle of a booby from its hatching on the floor of an island volcano to maturity.

•*Camels.* John Bonnett Wexo. Mankato, MN: Creative Education, 1989. 24 pp. Provides an introduction to camels.

Can You Find Me? A book about animal camouflage. Jennifer Dewey. New York, NY: Scholastic Inc., 1989. 40 pp. Explains how camouflage is used by birds, fish, insects, reptiles, and mammals.

•*Chick.* Jane Burton. New York, NY: Lodestar Books, 1992. 21 pp. Shows development of chick from egg.

Chicken and Egg. Christine Back and Jens Olesen. Morristown, NJ: Silver Burdett Press, 1986. 24 pp. Shows development of a chicken.

Chimpanzees and Bonobos. Ann Elwood. Mankato, MN: Creative Education, 1991. 24 pp. Gives an introduction to various chimpanzees.

City Geese. Ron Hirschi. New York, NY: Dodd, Mead, 1987. 45 pp. Examines a flock of Canadian geese.

Close to the Wild: Siberian tigers in a zoo. Thomas Cajacob and Teresa Burton. Minneapolis, MN: Carolrhoda Books, 1986. 48 pp. Shows the care and various aspects of behaviors of Siberian tigers.

Crane, The. Gabriel Horn. Mankato, MN: Crestwood House, 1988. 48 pp. Contains information on various kids of cranes.

Crocodile and the Crane, The: Surviving in a Crowded World. Judy Cutchins and Ginny Johnston. New York, NY: Morrow Junior Books, 1986. 54 pp. Shows how care and breeding in zoos protects endangered species.

Day in the Life of a Zoo Vet, A. David Paige. Mahwah, NJ: Troll Associates, 1985. 32 pp. Tells the story of the day the zoo veterinarian examined an elephant and operated on an armadillo.

Dear Bronx Zoo. Joyce Altman and Sue Goldberg. New York, NY: Macmillan, 1990. 156 pp. Describes the activities at a zoo and introduces various animals.

Dinosaurs and Birds. G. Minelli. New York, NY: Facts on File, 1987. 57 pp. Explains evolution theories relating dinosaurs and birds.

Discovering Songbirds. Colin S. Milkins. New York, NY: Bookwright Press, 1990. 47 pp. Introduces the characteristics and behaviors of songbirds.

Doctor Wotsit's Zoo. Felicia Law. Milwaukee, WI: Gareth Stevens Pub., 1986. 48 pp. Gives an introduction to the organization of a zoo.

Dodo, The. William R. Sanford and Carl R. Green. Mankato, MN: Crestwood House, 1989. 48 pp. Discusses the flightless bird of Mauritius and why it became extinct.

Dolphins & Porpoises. Beth Wagner Brust. Mankato, MN: Creative Education, 1991. 24 pp. Discusses the appearance and the habits of dolphins and porpoises.

Ducks, Geese and Swans. John Bonnett Wexo. Mankato, MN: Creative Education, 1989. 20 pp. Looks at some waterfowl in a zoo.

Eagles. Michael Bright. New York, NY: Gloucester Press, 1991. 31 pp. Discusses various eagles.

Eagles, Hawks, and Other Birds of Prey. Lynda De Witt. New York, NY: Franklin Watts, 1989. 63 pp. A discussion of vultures, eagles, kites, hawks, falcons, and owls.

Elephants. John Bonnett Wexo. Mankato, MN: Creative Education, 1989. 24 pp. Examines the ancestors of elephants and shows their appearance and behaviors.

Endangered Animals. John Bonnett Wexo. Mankato, MN: Creative Education, 1990. 24 pp. Tells what people do to endanger animals and shows pictures to identify endangered species.

Exotic Birds. Marilyn Singer. New York, NY: Doubleday, 1990. 44 pp. Discusses some of the more exotic birds such as the penguin and kiwi.

Feather Book, The. Karen O'Conner. New York, NY: Dillon Press, 1990. 59 pp. Discusses the structure, types, and colors of feathers.

**First Book of Bird Nests.* Millicent E. Selsam and Joyce Hunt. New York, NY: Walker & Company, 1984. 32 pp. Discusses bird nests.

First Look at Owls, Eagles, and Other Hunters of the Sky. Millicent E. Selsam and Joyce Hunt. New York, NY: Walker & Company, 1986. 32 pp. Explains about birds of prey.

Flightless Birds. Norman S. Barrett. New York, NY: Franklin Watts, 1991. 32 pp. Discusses several flightless birds.

Giant Pandas. John Bonnett Wexo. Mankato, MN: Creative Education, 1989. 24 pp. Introduces the giant panda bears.

Giraffes. John Bonnett Wexo. Mankato, MN: Creative Education, 1991. 24 pp. Gives the physical characteristics and behaviors of the tallest of our land animals.

Great Northern Diver: The loon. Barbara Juster Esbensen. Boston, MA: Little, Brown, 1990. 32 pp. Provides an introduction to the loon.

Great Zoo Hunt! The. Peppa Unwin. New York, NY: Doubleday, 1990. 32 pp. Provides a story where the reader helps the zookeeper locate 10 escaped animals hiding in detailed illustrations.

Have You Seen Birds? Joanne Oppenheim. New York, NY: Scholastic Inc., 1986. 32 pp. Gives simple descriptions of birds and their songs.

Headhunters and Hummingbirds: An expedition into Ecuador. Robert M. Peck. New York, NY: Walker & Company, 1987. 113 pp. Explains a journalist-photographer's expedition on ornithological research in the Cutucu Mountains.

Hippo. Caroline Arnold. New York, NY: Morrow Junior Books, 1989. 48 pp. Looks at hippos in the wild and those that live at the San Francisco Zoo.

How and Why Wonder Book of Birds, The. Robert Mathewson. Los Angeles, CA: Price, Stern, Sloan, 1987. 47 pp. Provides an introduction to birds.

Howell Beginner's Guide to Lovebirds. David Alderton (Editor). New York, NY: Howell Book House, 1984. 53 pp. Discusses the feeding, breeding, and showing of lovebirds.

Howell Beginner's Guide to Zebra Finches. David Alderton (Editor). New York, NY: Howell Book House, 1984. 53 pp. Discusses the feeding, breeding, and showing of zebra finches.

How to Draw Birds. Barbara Soloff-Levy. Mahwah, NJ: Watermill Press, 1987. 32 pp. Gives step-by-step instructions on how to draw birds.

How to Make a Miniature Zoo (3rd ed.). Vinson Brown. New York, NY: Dodd, Mead, 1987. 244 pp. Explains how to set up small zoos in your house.

Insect Zoo. Susan Meyers. New York, NY: Lodestar Books, 1991. 48 pp. Describes the San Francisco Insect Zoo.

* *I Spy at the Zoo.* Maureen Roffey. New York, NY: Aladdin Books, 1989. 29 pp. The reader finishes sentences by saying what is spied at a visit to the zoo.

It Could Still Be a Bird. Allan Fowler. Chicago, IL: Childrens Press, 1990. 31 pp. Explains the essential characteristics of birds and introduces penguins, peacocks, and the ostrich.

Julius. Trygve Klingsheim (English adaptation by Dalton Exleyl). New York, NY: Delacorte Press, 1987. 62 pp. Tells a story of a young zoo chimp who is adopted by humans after being rejected by the chimps.

Just Two Wings. Janet E. Givens. New York, NY: Atheneum, 1984. 28 pp. Deals with bird migration.

Killers—Birds. Philip Steele. Englewood Cliffs, NJ: Julian Messner, 1991. 32 pp. Explains the feeding habits of such birds as the Golden eagle, falcon and kingfisher.

Koalas. John Bonnett Wexo. Mankato, MN: Creative Education, 1989. 24 pp. Provides an introduction to koala bears.

Ko-Hoh: The call of the trumpeter swan. Jay Featherly. Minneapolis, MN: Carolrhoda Books, 1986. 48 pp. Tells the life cycle of the trumpeter swan.

Legs: The story of a giraffe. Phyllis Barber. New York, NY: McElderry Books, 1991. 71 pp. A young giraffe is captured in Kenya and transported to a zoo.

Life Cycle of a Swallow. John Williams. New York, NY: Bookwright Press, 1989. 32 pp. Shows the life cycle of a swallow.

Loon, The. Judith Pinkerton Josephson. Mankato, MN: Crestwood House, 1988. 47 pp. Discusses the physical characteristics, behaviors, and environment of the loon.

Loon Magic for Kids. Tom Klein. Minocqua, WI: North Wood Press, 1989. 47 pp. Gives the physical characteristics, habitat, and behavior of loons.

My First Visit to an Aviary. G. Sales and J.M. Parramon. New York, NY: Barron's, 1990. 31 pp. Tells how children from school visit an aviary at the zoo.

**My First Visit to the Zoo.* G. Sales and J.M. Parramon. New York, NY: Barron's, 1990. 31 pp. Tells how children visit a zoo and see the various animals.

Nature's Builders. Karen O'Callaghan. Newmarket, England: Brimax Books, 1988. 38 pp. Discusses nest building of birds.

New Zoos. Madelyn Klein Anderson. New York, NY: Franklin Watts, 1987. 71 pp. Shows how zoos are making more natural environments for their animals.

**1,2,3 To the Zoo: A counting book.* Eric Carle. New York, NY: Philomel Books, 1988. 28 pp. Each car on the train adds one more zoo animal, moving from 1 elephant to 10 birds.

Ostriches, Emus, Rheas, Kiwis, and Cassowaries. Ann Elwood. Mankato, MN: Creative Education, 1990. 24 pp. Provides an introduction to various zoo birds.

Ostrich, The. William R. Sanford and Carl R. Green. Mankato, MN: Crestwood House, 1987. 47 pp. Discusses the physical characteristics and behaviors of the ostrich.

Ostriches and Other Flightless Birds. Caroline Arnold. Minneapolis, MN: Carolrhoda Books, 1990. 47 pp. Introduces the ostrich, rhea, emu, cassowary, kiwi, and tinamou.

Owl in the Tree, The. Jennifer Coldrey. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Shows owls in their natural habitat.

Owls. Timothy L. Biel. Mankato, MN: Creative Education, 1990. 24 pp. Discusses owls, including their attack behavior and characteristics such as their wingspan.

Owls. Lynn M. Stone. Vero Beach, FL: Rourke Enterprises, 1989. 24 pp. Discusses owls and their enemies.

Passenger Pigeon, The. Susan Dudley Morrison. Mankato, MN: Crestwood House, 1989. 48 pp. Explains how this bird became extinct.

Penguin. Caroline Arnold. New York, NY: Morrow Junior Books, 1988. 48 pp. Shows how Humberto and Domino, a pair of Magellanic penguins, live at the San Francisco Zoo.

Penguin, The. Angela Royston. New York, NY: Warwick Press, 1988. 24 pp. Tells the life story of a penguin.

Penguins. John Bonnett Wexo. Mankato, MN: Creative Education, 1990. 24 pp. Gives a physical description and describes the habitat and behaviors of penguins.

Penguins, The. Lynn M. Stone. Mankato, MN: Crestwood House, 1987. 47 pp. Discusses the emperor penguin.

Peregrine Falcon, The. Carl R. Green and William R. Sanford. Mankato, MN: Crestwood House, 1986. 47 pp. Presents the life cycle of the peregrine falcon.

Pet Doctor. Harriet Langsam Sobol. New York, NY: G. P. Putnam's Sons, 1988. 32 pp. Follows the day of a veterinarian who is caring for cats, dogs, and birds.

**Pets and Animal Friends.* Vanessa Mitchell. Milwaukee, WI: Gareth Stevens Pub., 1985. 48 pp. Shows animals at home, in the garden, on the farm, and in the zoo.

Pets You Love, The. Jennifer C. Urquhart. Washington, DC: National Geographic Society, 1991. 34 pp. Discusses pleasures and responsibilities of having a pet bird, dog, rabbit, goldfish, and other family pets.

Pileated Woodpecker, The. Seliesa Pembleton. New York, NY: Dillon Press, 1989. 59 pp. Shows a year in the life of a woodpecker.

* *Polar Bear, Polar Bear, What Do You Hear?* Bill Martin, Jr. New York, NY: Henry Holt, 1991. 28 pp. Describes how the zoo animals make sounds for each other and how children can imitate them.

Protecting Endangered Species at the San Diego Zoo. Georgeanne Irvine. New York, NY: Simon & Schuster, 1990. 45 pp. Explains projects that scientists at the zoo are working on to protect such endangered animals as the clouded leopard.

Puffin. Naomi Lewis. New York, NY: Lothrop, Lee & Shepard Books, 1984. 30 pp. Traces the life of a puffin born on an island off the northern coast of Scotland.

Raising Gordy Gorilla at the San Diego Zoo. Georgeanne Irvine. New York, NY: Simon & Schuster, 1990. 45 pp. Discusses the early years of a gorilla born at the San Diego Zoo.

Rhinos. John Bonnett Wexo. Mankato, MN: Creative Education, 1991. 24 pp. Provides an introduction to the habits and physical characteristics of various species of rhinos.

Saving the Condor. Nancy T. Schorsch. New York, NY: Franklin Watts, 1991. 64 pp. Discusses the efforts to save the California condor.

Saving the Peregrine Falcon. Caroline Arnold. Minneapolis, MN: Carolrhoda, 1985. 48 pp. Explains efforts of scientists to prevent the extinction of this bird.

Seasons of Swans. Monica Wellington. New York, NY: Dutton, 1990. 32 pp. Tells about two swans who build a nest and raise a family.

Singing Birds and Flashing Fireflies. Dorothy Hinshaw Patent. New York, NY: Franklin Watts, 1989. 32 pp. Explains how various animals, including birds, communicate.

Snakes. John Bonnett Wexo. Mankato, MN: Creative Education, 1991. 24 pp. Discusses the bodies, locomotion, feeding, and behaviors of snakes.

Spiderwebs to Sky-Scrapers: The science of structures. David Darling. New York, NY: Dillon Press, 1991. 57 pp. Introduces a variety of structures including birds' nests.

State Birds. Arthur Singer. New York, NY: Lodestar Books, 1986. 63 pp. Shows and tells about each state bird.

Swans. Althea. Chicago, IL: Longman Group, 1988. 24 pp. Discusses the appearance, habits, reproduction, and migration of swans.

* *10 Things I Know about Penguins.* Wendy Wax and Della Rowland. Chicago, IL: Contemporary Books, 1989. 23 pp. Provides a simple introduction to penguins.

**Tigers.* Timothy Levi Biel. Mankato, MN: Creative Education, 1990. 24 pp. Provides an introduction to tigers.

Urban Roosts: Where birds nest in the city. Barbara Bash. Boston, MA: Little, Brown, 1990. 32 pp. Discusses birds that live in the city.

Visit of Two Giant Pandas at the San Diego Zoo, The. Georgeanne Irvine. New York, NY: Simon & Schuster, 1991. 45 pp. Relates the story of two pandas from China, Basi and Yuan Yuan, that came to visit the San Diego Zoo.

Visit to the Zoo, A. Sylvia Root Tester. Chicago, IL: Childrens Press, 1987. 31 pp. Tells a story of a group that goes on a class trip to the zoo.

What Do You Do at a Petting Zoo? Hana Machotka. New York, NY: Morrow Junior Books, 1990. 32 pp. Describes the function of a petting zoo and tells about the kinds of animals found there.

What Happens at the Zoo. Judith E. Renard. Washington, DC: National Geographic Society, 1984. 32 pp. Discusses various functions of people who work at the zoo.

What Is a Bird? Ron Hirschi. New York, NY: Walker & Company, 1987. 31 pp. Explains basic concepts of birds.

When We Went to the Zoo. Jan Ormerod. New York, NY: Lothrop, Lee & Shepard Books, 1991. 36 pp. Discusses how two children enjoy a tour of the zoo.

Where Do Birds Live? Ron Hirschi. New York, NY: Walker & Company, 1987. 32 pp. Examines the natural habitats of birds: ponds, rivers, mountains, old trees, yards, and so forth.

Where the Bald Eagles Gather. Dorothy Hinshaw Patent. New York, NY: Clarion Books, 1984. 56 pp. Discusses the wildlife research and the banding of birds in Glacier National Park.

Wild Goat. Caroline Arnold. New York, NY: Morrow Junior Books, 1990. 48 pp. Examines Daisy and Chaim, two goats who live at the Los Angeles Zoo, through text and photos.

Windows on Wildlife. Ginny Johnston and Judy Cutchins. New York, NY: Morrow Junior Books, 1990. 48 pp. Shows zoos, wildlife parks, and aquariums.

Who Lives In—the Mountains? Ron Hirschi. New York, NY: G. P. Putnam's Sons, 1989. 32 pp. Shows the birds and animals of the high country.

Who Lives on—the Prairie? Ron Hirschi. New York, NY: G. P. Putnam's Sons, 1989. 32 pp. Discusses such birds and animals as the prairie dog, dancing birds, and weasels.

Whooping Crane: A comeback story, The. Dorothy Hinshaw Patent. New York, NY: Ticknor & Fields, 1988. 88 pp. Traces attempts to save the cranes from extinction.

Wild Turkey, Tame Turkey. Dorothy Hinshaw Patent. Boston, MA: Houghton Mifflin, 1989. 57 pp. Gives the history of the North American turkey.

Wind to Flight. Peter Lafferty. New York, NY: Gloucester Press, 1989. 32 pp. Explains how the wind is used by seeds, clouds, birds, insects, and machines.

Wolves, John Bonnett Wexo. Mankato, MN: Creative Education, 1990. 24 pp. Gives a physical description and describes the habitat and behaviors of wolves.

Work of the Zoo Doctors at the San Diego Zoo, The. Georgeanne Irvine. New York, NY: Simon & Schuster, 1991. 45 pp. Describes the work of zoo veterinarians.

**Zachary Goes to the Zoo.* Jill Krementz. New York, NY: Random House, 1986. 20 pp. Shows a child's visit to the zoo through text and photos.

Zoo. Gail Gibbons. New York, NY: Thomas Y. Crowell, 1987. 30 pp. Shows behind-the-scenes at a zoo on a typical working day.

Zoo Animals. Sandy Cortright. New York, NY: Barron's, 1990. 79 pp. Contains facts about zoo animals.

Zoo Animals. Photos by Philip Dowell and Jerry Young. New York, NY: Macmillan, 1991. 21 pp. Through photos, shows various zoo animals including the elephant, monkey, zebra, and camel.

Zoobabies. Carolyn Fireside. New York, NY: Villard Books, 1991. 58 pp. Shows zoo animals in their infancy.

Zoo Clues: Making the most of your visit to the zoo. Sheldon L. Gerstenfeld. New York, NY: Viking Penguin, 1991. 113 pp. Gives information on favorite zoo animals.

Zoo Day. John Brennan and Leonie Keaney. Minneapolis, MN: Carolrhoda Books, 1989. 32 pp. Shows a typical zoo day through text and photos.

Zoos and Game Reserves. Miles Barton. New York, NY: Gloucester Press, 1988. 32 pp. Discusses zoos and wild life refuges.

Zoo Workers. Judith Stamper. Mahwah, NJ: Troll Associates, 1989. 32 pp. Describes the jobs of various people who work in the zoo, such as acquiring animals, preparing food, and caring for sick animals.

Other resources

The following magazines might be of interest as you explore the world of birds: *Audubon, Conservationist, Country Journal, Field and Stream, International Wildlife, National Wildlife, Natural History, Nature Canada, Outdoor Life, Petersen's Photographic Magazine, Science, The Sporting News, Sports Afield,* and *Wilderness.*

The following magazines might be of interest as you explore zoos: *Curator, Journal of the American Veterinary Medical Association, New Scientist,* and *Zoo Biology.*

All About Animals. Donald Thompson & Associates. Los Angeles, CA: Hi-Tops Video, 1987. 1 videocassette, 30 minutes. For ages 3–6. A classroom full of puppets visit a zoo.

Animal Guessing Games. National Geographic Society, 1988. 1 videocassette, 15 minutes. Asks and answers various questions about animals.

Babies of the Pond. Jill Grunkmeyer (Producer). Sheridan, WY: Grunko Films, 1988. 1 videocassette, 45 minutes. About infant birds and pond ecology.

Captain Kangaroo—Let's go to the zoo with Captain Kangaroo. (MPI EB5051). Chicago, IL: Britannica Education Corporation (distributed by MPI Home Video), 1985. 1 videocassette, 58 minutes. Contains animated and live action.

Economy Incubator/Brooder (57–090–0492). Hudson, NH: Delta Education, Inc. Small incubator in which to hatch chicken eggs.

Field Guide to Bird Songs of Eastern and Central North America, A (Cr02). Boston, MA: Houghton Mifflin, 1990. 2 sound cassettes. Peterson field guide series.

Loon Magic. Tom Klein. Louisville, CO: Audio Press, 1990. 2 sound cassettes. Gives a variety of information about the loon.

National Zoo, The. Terence Taylor. Rochester, NY: Eastman Kodak, 1989. 1 videocassette, 50 minutes. Shows famous and unusual residents of the Smithsonian Institution's living animal collection.

Pandas in Person. Minneapolis, MN: Quality Video, 1989. 1 videocassette, 30 minutes. Examines the life styles and habits of panda bears.

Song Birds. Ithaca, NY: Library of Natural Sounds, Laboratory of Ornithology, Cornell University, 1988. 1 sound cassette. Provides the songs of several birds.

Zookeepers. Dugan Rosalini (Producer). Chicago, IL: Films Incorporated Video, 1989. 1 videocassette, 29 minutes. Shows a visit to Chicago's Lincoln Park Zoo.

Zoo-Opolis!. David Lee Miller. Beverly Hills, CA: Pacific Arts Video, 1985. 1 videocassette, 88 minutes. A visit to the zoo, including a discussion with the keepers and a look at the various animals.

Exploring geology and paleontology

It is a rare child indeed who has not gathered up rocks, pounded sandstone into dust, or asked questions about dinosaurs. These seem to be universal interests of boys and girls, and so it should be a simple task to lead them into further explorations of geology and paleontology.

To adults, rocks found in the garden, along a stream, or in decorative borders and walks may look pretty much alike. However, to a curious child, each and every rock can be both beautiful and fascinating. The child may like the colors in one, the shape of another, and the smoothness of a third. Examining these rocks helps develop powers of observation and can be a springboard to a more rigorous scientific examination.

Starting a rock collection

Many children will like to have a rock collection. These can be purchased or it is fun to collect your own rocks and try to identify them. To make your own rock collection, tape or glue small pieces of rock into a shallow box. Beneath each specimen, put an identifying number.

On the cover of the box (or in a notebook) put the corresponding number and any information that you know about the rock. You might list where you found the rock, its color, hardness, and even the type of rock it is, if you know.

You can add to this collection over many months. You may even want to purchase a special rock from a shop while on vacation to add to the collection. Arrowheads, agates, turquoise, crystals, or a fern or trilobite fossil, are just a few of the inexpensive items you might want to add to the collection.

Rocks are made from a mixture of minerals. For example, the salt that you eat is a mineral named halite. Making salt crystals is easy to do.

Making salt crystals

Boil 1 cup of water. Dissolve 4 tablespoons of salt in the water. Pour the cooled salty solution into a narrow jar so that it is about ⅓ full.

Tie a piece of string onto the middle of a pencil. Drop the string into the salty water and lay the pencil across the top of the jar. Put the jar in a cool place where it will not be disturbed for several days.

After about four days, little salt crystals in perfect cubes will form on the string.

If a class of students or an adult and one curious child are going to really start exploring rocks, the following few simple items should be collected and placed in your rock kit: a knife, for scratching stones; a piece of glass (with smooth edges so that you won't cut yourself) to make scratches on; a magnifying glass to examine rocks; a penny; a tile; a hammer for breaking rocks open; and some gingerale or soda pop.

Performing a hardness test on rocks

The hardness test is one that you will want to be able to apply to the rocks that you find.

Hardness 1 = You can scratch it easily with your fingernail. Talc is an example.

Hardness 2 = You can scratch it with your fingernail but it isn't easy to do so. Gypsum is an example.

Hardness 3 = You can't scratch it with your fingernail, but you can scratch it with a penny. Calcite is an example.

Hardness 4 = You can't scratch it with a fingernail or a penny, but you can with a knife. Limestone is an example.

Hardness 5 = You can just barely scratch this stone with a knife. Hornblende is an example.

Hardness 6 = You can't scratch it with a knife, but it will scratch the flat knife blade or glass. Feldspar is an example.

Hardness 7 = You can scratch glass with this rock. Quartz is an example.

Scientists carry their scale to a hardness of 10. Topaz is an example of Hardness 8. Corundum is an example of Hardness 9. (Precious corundum includes the ruby and sapphire.) Diamonds have a Hardness of 10.

Some students may be more interested in gemstones, silver, or gold than in the more ordinary garden variety rocks. Rock tumblers are available, and it might be possible to set one up and polish some rocks. If there are mines in your area (e.g., gold, silver, turquoise), you may be able to invite a gold or silver miner to visit and bring ore samples or you may be able to visit a gift shop associated with a turquoise mine or a local rock or gem shop.

A child may notice that the silver at home gets a tarnish on it. This tarnish comes from a chemical reaction to sulfur dioxide, a gas that is present in the air in small quantities. The following experiment will help show the child how to remove such tarnish.

Removing tarnish from a silver spoon

Use aluminum foil, shiny side up, to line the inside of a saucepan. Into the saucepan, put 4 cups of water, 1 tablespoon baking soda, and 1 teaspoon of salt. Stir gently.

Put a tarnished silver spoon into the saucepan. Bring the water to a boil on a hot plate or the stove.

In about 15 minutes, the tarnish will disappear. Let the water cool. Remove the spoon. Pour out the water and examine the aluminum foil.

The used foil may now look tarnished because it has a coating of aluminum sulfide. (The hot baking soda solution broke up the silver sulfide into ions of silver and ions of sulfur. The sulfur ions moved to the surface of the aluminum because aluminum is more reactive with sulfur than silver.)

Another simple test is the test for limestone. Limestone is formed when calcite on land is dissolved in rainwater and is carried by brooks and rivers to the sea. Shellfish, corals, and a few sea plants are able to take the lime from the water. When they die, they pile up on the bottom of the ocean and over a period of time, form limestone.

Since ancient sea bottoms are now high on land, it is easy to find limestone in many places.

Performing a limestone test

If you think you have found a piece of limestone for your rock collection, you can perform this test. Pour soda water onto your rock; if it is limestone, the lime will bubble and fizz.

Where there is a lot of limestone, you may also find very interesting caves. Many of these caves are open to public tours. There may be one in your area that would make a good class field trip site or you may visit one when on vacation.

These special caves are formed when water, seeping underground, passes over limestone with calcite in it. Some of the calcite dissolves in the water. As it drips, some of the calcite sticks to the roof of a cave (forming stalactites) or dribbles into a pile on the floor of a cave (forming stalagmites). Sometimes the stalactites and the stalagmites grow together like a pillar. The Carlsbad Caverns of New Mexico, the Luray Caverns and Weyers Cave in Virginia, and Mammoth Cave in Kentucky are especially famous.

Some of our finest fossils, such as shells, corals, and other sea creatures or their prints, are found in limestone deposits. Depending on where you live, you may be able to find fossils or perhaps can visit a museum to see fossil specimens.

When children learn about fossils and prehistoric times, they often become interested in dinosaurs. Notable museums with major fossil collections can be found in New York, NY; Pittsburgh, PA; Chicago, IL; Denver, CO; Vernal, UT; Cambridge, MA; Los Angeles, CA; New Haven, CT: Princeton, NJ; Washington, DC; Rapid City, SD; Berkeley, CA; Lawrence, KS; Lincoln, NE; Baird, TX; and Laramie, WY. Many smaller museums also have interesting collections.

You may decide to visit a natural history museum, a museum of science, a whaling museum, a local historical museum, or any one of countless other museums and collections that may be available to you. You and your curious student may wish to go on your own or you may want to be part of a guided tour.

Taking a class of students on a guided tour to a natural history museum may be a great addition to a unit of study on dinosaurs or it may serve as a culminating activity.

Sometimes tours include behind-the-scenes glimpses of how different aspects of an exhibit are put together. Occasionally a major exhibit may come somewhere near you as part of a traveling exhibit. By being alert to these opportunities, you will maximize your viewing possibilities.

Preparing a display

After seeing a collection displayed, a child may want to prepare a simple display of his or her own. Perhaps one child or a class will want to prepare a rock collection as a display with attractive background and detailed labels providing pertinent information.

Friends relatives, or other classes may be invited to come and view the display.

Current events may also spark interest in geology. If children hear about an earthquake, a meteor, or a volcanic eruption somewhere in the world, they may have a lot of questions. Make the most of these teachable moments by pursuing these interests when they arise.

The resources that follow should help you as you explore rocks, fossils and dinosaurs. Other resources that may also be helpful can be found in Chapters 1, Exploring chemistry in the kitchen; 3, Exploring science in the backyard; 4, Exploring botany; and 8, Exploring geography and cartography.

Resource books

Activities for Anyone, Anytime, Anywhere: A children's museum activity book. Jeri Robinson. Boston, MA: Little, Brown, 1983. 88 pp. Contains ideas for museum activities.

Adventures with Rocks and Minerals: Geology experiments for young people. Lloyd H. Barrow. Hillside, NJ: Enslow Pub., 1991. 96 pp. Contains many earth science experiments.

**Age of Dinosaurs, The.* David Lambert. New York, NY: Random House, 1987. 24 pp. Provides a brief introduction to dinosaurs.

Age of Dinosaurs!, The. Steve Parker. Milwaukee, WI: Gareth Stevens Pub., 1985. 48 pp. Provides an introduction to prehistoric animals.

All about Arrowheads and Spear Points. Howard E. Smith, Jr. New York, NY: Henry Holt, 1989. 56 pp. Describes different types of arrowhead and spear points.

Amazing Science: Quicksand and other earthy wonders. Q.L. Pearce. Englewood Cliffs, NJ: Julian Messner, 1989. 64 pp. Explores quicksand, geysers, caves, and peat bogs.

Big Rock, The. Bruce Hiscock. New York, NY: Atheneum, 1988. 30 pp. Tells about the origins of a granite rock located near the Adirondack Mountains.

Born of Heat and Pressure: Mountains and metamorphic rocks. Patricia L. Barnes-Svarney. Hillside, NJ: Enslow Pub., 1991. 64 pp. Discusses the formation of rocks and mountains.

Born Near the Earth's Surface: Sedimentary rocks. Sally M. Walker. Hillside, NJ: Enslow Pub., 1991. 64 pp. Examines the formation and types of sedimentary rocks.

Building Your Own Nature Museum: For study and pleasure. Vinson Brown. New York, NY: ARCO Publishing, 1984. 161 pp. Explains how to acquire, care for, preserve, classify, and display your own nature museum.

Cave. Lionel Bender. New York, NY: Franklin Watts, 1989. 32 pp. Discusses the ways in which caves are formed.

Caves. Keith Brandt. Mahwah, NJ: Troll Associates, 1985. 30 pp. Discusses the formation of caves.

**Caves.* Jenny Wood. New York, NY: Puffin Books, 1990. 27 pp. Provides an introduction to caves.

Clocks in the Rocks: Learning about earth's past. Patricia L. Barnes-Svarney. Hillside, NJ: Enslow Pub., 1990. 64 pp. Examines fossils, radioactive dating, and prehistoric life.

Colossal Fossils: Dinosaur riddles. Charles Keller (Compiler). New York, NY: Prentice-Hall Books for Young Readers, 1987. 63 pp. Contains humorous riddles.

Comets, Meteors, and Asteroids: Rocks in space. David J. Darling. New York, NY: Dillon Press, 1984. 64 pp. Gives origins, characteristics, and behaviors of various kinds of rocks in space.

Copycats and Artifacts: 42 creative artisan projects to make. Marianne Ford. Boston, MA: D. R. Godine, 1986. 96 pp. Contains instructions for making projects modeled after museum artifacts.

Crystal and Gem. R. F. Symes. New York, NY: Alfred A. Knopf, 1991. 63 pp. Discusses crystals, the seven basic shapes, how they are formed, and how crystals and gems are used.

Crystals and Crystal Gardens You Can Grow. Jean Stangl. New York, NY: Franklin Watts, 1990. 64 pp. Contains ideas for experiments that explain about crystals.

Dating Dinosaurs and Other Old Things. Karen Liptak. Brookfield, CT: Millbrook Press, 1992. 72 pp. Explains the techniques used by scientists to date bones, rocks, and famous old art works.

Detecting the Past. Mike Corbishley. New York, NY: Gloucester Press, 1990. 32 pp. Explores the new developments in studying ancient rocks.

Did Comets Kill the Dinosaurs? Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Offers a possible explanation for the extinction of the dinosaurs.

Digging Up Dinosaurs. Aliki. New York, NY: Thomas Y. Crowell, 1988. 32 pp. Explains how scientists study fossil remains.

Dimetrodon. Rupert Oliver. Vero Beach, FL: Rourke Enterprises, 1984. 20 pp. Shows a busy day in the life of Dimetrodon.

Dinosaur. David Norman. New York, NY: Alfred A. Knopf (distributed by Random House), 1989. 63 pp. Discusses dinosaurs and examines their teeth, feet, and eggs.

•*Dinosaur Alphabet Book.* Pat Whitehead. Mahwah, NJ: Troll Associates, 1985. 30 pp. Provides characteristics of different dinosaurs for each letter of the alphabet.

Dinosaur Cousins? Bernard Most. San Diego, CA: Harcourt Brace Jovanovich, 1987. 32 pp. Examines 19 modern animals that resemble the ancient dinosaurs.

Dinosaur Fossils. Alvin Granowsky. Austin, TX: Steck-Vaughn Library, 1992. 32 pp. Discusses fossils and the work of paleontologists.

Dinosaurs. Daniel Cohen. New York, NY: Doubleday, 1986. 41 pp. Introduces dinosaurs.

Dinosaurs. Gail Gibbons. New York, NY: Holiday House, 1987. 30 pp. Discusses a variety of dinosaurs.

Dinosaurs and Birds. Giuseppe Minelli. New York, NY: Facts on File, 1987. 57 pp. Discusses evolutionary theories relating dinosaurs to birds.

Dinosaurs and Other First Animals. Dean Morris. Milwaukee, MN: Raintree Childrens Books, 1988. 47 pp. Offers an easy-to-read story about dinosaurs.

Dinosaurs Down Under: And other fossils from Australia. Caroline Arnold. Boston, MA: Houghton Mifflin, 1990. 48 pp. Explains how a museum exhibit is shipped.

Dinosaurs, Dragonflies, & Diamonds: All about natural history museums. Gail Gibbons. New York, NY: Four Winds Press, 1988. 32 pp. Discusses the behind-the-scenes work at a natural history museum and what you can expect to find there.

Dinosaurs: Opposing viewpoints. Peter and Connie Roop. St. Paul, MN: Greenhaven Press, 1987. 95 pp. Discusses possible reasons for the extinction of dinosaurs.

Dinosaurs: Poems. Lee Bennett Hopkins. San Diego, CA: Harcourt Brace Jovanovich, 1987. 46 pp. Provides a collection of 18 dinosaur poems.

Dinosaurs Walked Here, and Other Stories Fossils Tell. Patricia Lauber. New York, NY: Bradbury Press, 1987. 56 pp. Explains how fossilized remains of plants and animals reveal information about the prehistoric world.

Discovering Dinosaurs: All up-to-date guide, including the newest theories. Victoria Crenson. Los Angeles, CA: Price, Stern, Sloan, 1988. 79 pp. Describes the ways in which paleontologists learn from fossils.

Discovering Dinosaur Babies. Miriam Schlein. New York, NY: Four Winds Press, 1991. 39 pp. Suggests how dinosaurs cared for their young.

Earthquake! Jules Archer. Mankato, MN: Crestwood House, 1991. 48 pp. Describes the nature, origin, and dangers associated with earthquakes.

Earthquakes. Franklyn Mansfield Branley. New York, NY: Thomas Y. Crowell, 1990. 32 pp. Explains why earthquakes occur and identifies the danger zones.

Earthquakes. Christopher Lampson. Brookfield, CT: Millbrook Press, 1991. 64 pp. Discusses the causes and results of earthquakes.

Earthquakes. Seymour Simon. New York, NY: Morrow Junior Books, 1991. 32 pp. Describes how and when earthquakes occur and how they can be predicted.

Earthquakes & Volcanoes. Ruth Deery. Carthage, IL: Good Apple, 1985. 42 pp. An activity book on earthquakes and volcanoes.

Exploring Soil and Rocks. Ed Catherall. Austin, TX: Steck-Vaughn Library, 1991. 48 pp. Contains experiments involving the composition of soil of rocks.

Family of Dinosaurs, A. Mary LeDuc O'Neill. Mahwah, NJ: Troll Associates, 1989. 29 pp. Discusses the family of dinosaurs.

First Look at Rocks, A. Millicent E. Selsam and Joyce Hunt. New York, NY: Walker & Company, 1984. 32 pp. Provides an introduction to the distribution and characteristics of various rocks.

Fossil. Paul D. Taylor. New York, NY: Alfred A. Knopf, 1990. 63 pp. Provides a photo essay of different types of fossils.

Fossil Factory, The: A kid's guide to digging up dinosaurs, exploring evolution, and finding fossils. Niles Eldredge. Reading, MA: Addison-Wesley Publishing Co., 1989. 111 pp. Describes fossils and explains how to collect them.

Fossils. Allan Roberts. Chicago, IL: Childrens Press, 1983. 45 pp. Explains the process of fossilization.

Fossils. John Stidworthy. New York, NY: M. Cavendish, 1989. 47 pp. Provides information and suggests activities for learning about fossils.

Fossils: Stories from bones and stones. Patricia L. Barnes-Svarney. Hillside, NJ: Enslow Pub., 1991. 64 pp. Discusses the history and formation of fossils.

Fossils Tell of Long Ago. Aliki. New York, NY: Thomas Y. Crowell, 1990. 32 pp. Explains how fossils are formed and what they tell us.

Glacier. Lionel Bender. New York, NY: Franklin Watts, 1988, 32 pp. Discusses glaciers and what they do.

**How and Why Wonder Book of Rocks and Minerals.* Nelson W. Hyler. Los Angeles, CA: Price, Stern, Sloan, 1989. 47 pp. Provides an introduction to rocks and minerals.

How Big Is a Brachiosaurus? Fascinating Facts About Dinosaurs. Susan Carroll. New York, NY: Platt & Munk, 1986. 32 pp. Gives questions and answers about dinosaurs.

Hunting the Dinosaurs and Other Prehistoric Animals. Jane Burton. Milwaukee, WI: Gareth Stevens Pub., 1987. 32 pp. Discusses the work of paleontologists.

I Can Be a Geologist. Paul P. Sipiera. Chicago, IL: Childrens Press, 1986. 29 pp. Discusses the education and training needed for a variety of jobs associated with geology.

If You Are a Hunter of Fossils. Byrd Baylor. New York, NY: Aladdin Books, 1984. 32 pp. Tells of a fossil hunter in western Texas.

Jurassic Dinosaurs, The. Dougal Dixon. Milwaukee, WI: Gareth Stevens Pub., 1987. 32 pp. Discusses 11 dinosaurs of the Jurassic.

Last Dinosaurs, The. Jane Burton and Dougal Dixon. Milwaukee, WI: Gareth Stevens Pub., 1987. 32 pp. Presents several dinosaurs and other prehistoric reptiles.

Learning about the Dinosaurs. Dougal Dixon. Milwaukee, WI: Gareth Stevens Pub., 1989. 32 pp. Explains how paleontologists discover, reconstruct, and restore fossils.

Let's Go Dinosaur Tracking! Miriam Schlein. New York, NY: HarperCollins, 1991. 47 pp. Shows dinosaur tracks and what they reveal.

Let's Go to the Museum. Lisl Weil. New York, NY: Holiday House, 1989. 32 pp. Explains different jobs in a museum including director, curator, trustee, and conservator.

Making Your Own Nature Museum. Ruth B. Alford MacFarlane. New York, NY: Franklin Watts, 1989. 128 pp. Gives instructions for collecting, preserving, identifying, and displaying a collection.

Mighty Mammals of the Past. John Stidworthy. Morristown, NJ: Silver Burdett Press, 1986. 37 pp. Discusses what we have learned about early mammals from fossilized remains.

Nature's Great Carbon Cycle. Lorus J. Milne and Margery Milne. New York, NY: Atheneum, 1983. 84 pp. Discusses how radiocarbon dating of organic matter in fossils is done.

On the Tracks of Dinosaurs. James O. Farlow. New York, NY: Franklin Watts, 1991. 72 pp. Contains a discussion of footprints and how these are used by paleontologists.

Physical World, The. Tony Seddon. New York, NY: Doubleday, 1987. 159 pp. Examines the physical and chemical structures of our earth.

Prehistoric Animals. Daniel Cohen. New York, NY: Doubleday, 1988. 41 pp. Discusses 20 prehistoric animals and their modern counterparts.

Prehistoric Monsters Did the Strangest Things. Leonora and Arthur Hornblow. New York, NY: Random House, 1990. 62 pp. Presents many strange prehistoric animals in a chronological order.

Prehistoric World. Michael Benton. New York, NY: Simon & Schuster, 1987. 128 pp. Examines prehistory from the first plants to the first animals.

Ranger Rick's Dinosaur Book. Victor H. Waldrop and Michael E. Loomis. Washington, DC: National Wildlife Federation, 1984. 95 pp. Discusses various kinds of dinosaurs.

**Rock, The.* Peter Parnall. New York, NY: Macmillan, 1991. 32 pp. Traces a rock over the years.

**Rocks and Soil.* Terry J. Jennings. Chicago, IL: Childrens Press, 1989. 34 pp. Contains ideas for activities and experiments to introduce the topics of rocks and soil.

Rocks and Minerals. R. F. Symes. New York, NY: Alfred A. Knopf, 1988. 63 pp. Discusses rocks, their creation, erosion, and aspects of mining.

Rocks and Minerals. Kathryn Whyman. New York, NY: Gloucester Press, 1989. 32 pp. Provides an introduction to rocks and minerals.

Rocks, Minerals and Fossils. Keith Lye. Morristown, NJ: Silver Burdett Press, 1991. 48 pp. Provides an introduction to rocks, minerals, and fossils.

**Rocks, Rocks, Big and Small.* Joanne Barkan. Morristown, NJ: Silver Burdett Press, 1990. 30 pp. Offers an introduction to rocks.

Science for Kids: 39 easy geology experiments. Robert W. Wood. Blue Ridge Summit, PA: TAB Books, 1991. 133 pp. Contains a variety of experiments for performing tests on rocks and growing crystals.

Start Collecting Rocks and Minerals. Lee Ann Srogi. Philadelphia, PA: Running Press, 1989. 127 pp. Explains how to organize minerals, crystals, and rocks in a collection.

Trapped in Tar: Fossils from the Ice Age. Caroline Arnold. New York, NY: Clarion Books, 1987. 57 pp. Examines the fossils of the La Brea Tar Pits in California through text and photos.

Visit to the Natural History Museum, A. Sandra Ziegler. Chicago, IL: Childrens Press, 1988. 31 pp. Using the format of a tour, the reader learns about the reconstruction of dinosaurs, plants, and an Indian lodge.

Volcano. Christopher Lampton. Brookfield, CT: Millbrook Press, 1991. 64 pp. Discusses four types of volcanoes.

Volcanoes and Earthquakes. Mary Elting with Rachel Folsom and Robert Moll. New York, NY: Simon & Schuster, 1990. 40 pp. Discusses how volcano activity and earthquakes occur and how they are predicted.

* *Volcanoes and Earthquakes.* Zuza Vrbova. Mahwah, NJ: Troll Associates, 1990. 32 pp. Offers an introduction to volcanoes and earthquakes.

Whatever Happened to the Dinosaurs? Bernard Most. San Diego, CA: Harcourt Brace Jovanovich, 1984. 36 pp. Contains humorous speculation about what might have happened to dinosaurs.

Where Are all of the Dinosaurs? Mary O'Neill. Mahwah, NJ: Troll Associates, 1989. 32 pp. Examines fossils to explain why dinosaurs disappeared.

Why Do Volcanoes Erupt? Questions about our unique planet answered by Dr. Philip Whitfield with the Natural History Museum. Philip Whitfield. New York, NY: Viking Penguin, 1990. 36 pp. Answers many questions about volcanoes.

Zion National Park. Ruth Radlauer. Chicago, IL: Childrens Press, 1988. 48 pp. Discusses the rock formations of Utah's Zion Park.

Other resources

American Museum of Natural History. Glastenbury, CT: Video Tours, 1990. 1 videocassette, 40 minutes. Explores the fascinating exhibits of the American Museum of Natural History.

Before You Visit a Museum. Stamford, CT: The Group, 1987. 1 videocassette, 14 minutes. Pt. 1, Finding your way around. Pt. 2, Getting the most from your visit.

Dinosaurs: Lessons from bones. Hightstown, NJ: American School Publishers, 1991. 1 videocassette, 24 minutes. Shows fossil research in the field and in the museum.

Dinosaur World. Geoffrey T. Williams. Los Angeles, CA: Price, Stern, Sloan, 1986. 1 book, 32 pp.; 1 sound cassette, 20 minutes. A tapekit about the world of dinosaurs.

Earthquake! Disaster in L.A. (57–220–0890). Hudson, NH: Delta Education, Inc. Video showing the power of an earthquake.

Eruption of Mt. St. Helens (57–220–0901). Hudson, NH: Delta Education, Inc. Video showing a volcanic eruption.

Growing Crystal Gardens Kit (57–716–0570). Hudson, NH: Delta Education, Inc. Contains materials needed to grow crystals, plus a hand lens for observation and a guide.

Rock Collection (57–110–0219). Hudson, NH: Delta Education, Inc. An introductory rock collection of 15 specimens.

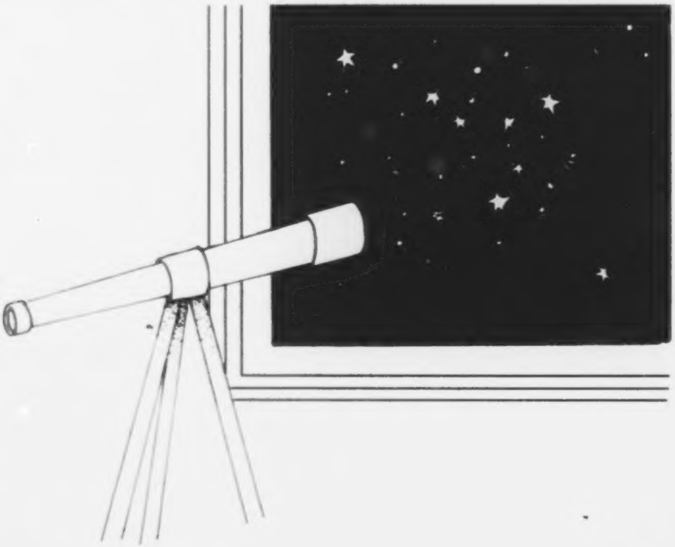
Seismograph Model (57–130–3708). Hudson, NH: Delta Education, Inc. A model to show how a seismograph works.

Volcano Kit (57–110–1000). Hudson, NH: Delta Education, Inc. Materials and a guide for making a volcano model.

7

Exploring astronomy

Backyard sky watching or a night school session to look at the heavens can be a lot of fun. If you live in a city where there are many lights, you may have to trade backyard astronomy for a star watch while on a camping trip in the mountains. But even in the city, with a trained eye, a teacher or other adult can help children find out a lot about the mysteries of the sky.



Perhaps the curious child in your life comments early one evening that the star he or she can see from your backyard over the mountains at the edge of town is especially bright and seems to be up earlier than all the others. Perhaps late one night while driving home on an especially clear night, you point out to the child that a lot of the constellations, or star pictures, are easy to see this evening. Maybe a class discussion begins when a student reports that he or she saw a "falling star" last night. Or perhaps on a family camping trip, a child comments that he or she has never seen so many stars in the sky before. Any of these may be an opening to begin some exploring of astronomy.

As in all areas with curious kids, the adult needs to be guided by the interest shown. Don't tell too much or go into such complex answers that it becomes boring. If the child is really interested, the questions will keep coming, and you'll know that this is an area for some in-depth exploration.

If a unit of study in the classroom or an individual child's interest at home persists over several weeks, the class of students or the child will come to realize that the sky looks "different" each and every night. A child may ask why it changes. Another student may also notice that the moon seems to change its shape and be curious about that aspect of the night sky.

One of the first steps in sky watching is to orient yourself with respect to north, south, east, and west. Using shadows is a good way to do this. The following experiment will explain how to make a shadow board, which will help you orient yourself.

Making a shadow board

You can help a child make a shadow board by cutting and fastening a stick or dowel upright in the center of an 8-inch-square board.

Take the board outside and put it on a level spot of ground. In the United States at noontime, there will be a short shadow, which indicates the north-south line since the sun is directly toward the south at this time. This will help you orient yourself for sky watching by knowing the directions in your own back yard.

At night, you can look for the Big Dipper above the northern horizon all during the year. Older youth may need to learn about azimuth (the position of an object relative to north) and altitude (where an object lies between the horizon and the zenith). Various references included in the Resource books section of this chapter will show you how to make a simple device for determining azimuth and altitude.

Once you are certain about the directions from the spot where you and the child will be observing, many simple activities are possible.

Drawing a sky map

Together you can make a map of the eastern skyline from a convenient window in the house, showing trees, buildings, or other features.

Then make a similar map of the western skyline.

Note on your eastern sky map where the sun rises each day, and date your observation. Similarly, note on your western sky map where the sun sets each night and date your observations.

You may skip days or even weeks between your observations.

You will find that during winter, the sun rises south of east and sets south of west. On the first day of spring, it will rise due east and set due west.

Such mapping and graphing experiences may be very intriguing to a child who comes to have a sense of discovery about the objects in the sky.

If a child or a group of students show an interest in the sun and its position, you might want to continue your study by using a sundial to tell time. You can purchase one or you may find it challenging to make one. There are many ways to go about this. You can make a simple sundial (which won't last) from cardboard or you can make a heavy duty one from wood or metal.

Making a cardboard sundial

You need to know your latitude to make a working sundial. The directions below are for making a sundial at a latitude of 40 degrees.

Cut a 6-inch-square piece of stiff cardboard. Use a protractor to draw a line marking a 40-degree angle for the longest side of a triangle, which will be about 7¾ inches long. Cut out this right-angled triangle.

Take a piece of cardboard that is 12 inches long by 6 inches wide. Draw a half-circle on it that has a 6-inch radius. Cut out the semicircle.

Use tape to attach your triangle to the semicircle. The sloping side of the triangle should point to the center of the semicircle.

Place the sundial outside. Use a compass to align the triangle north and south. The tallest side of the 40-degree angle should point north.

Then mark the position of the sun's shadow on the base of your sundial every hour. You can begin at 6 A.M. on the left side of the triangle. At the back of your triangle should be 12 noon. Number again to about 6 P.M. on the right side of the triangle. Your marks should be equal distance around the half-circle with 12 noon pointing true north.

Now by looking at the shadow cast on the base of your sundial, you can tell time on a sunny day.

A visit to a planetarium with a curious child or a classroom of students can be a very special treat. It is a judgment call as to whether you do preparation before the visit or whether you follow-up afterwards with explorations into areas that seemed of particular interest. Both kinds of activities can be useful.

If you have access to a planetarium, there is probably a brochure available that details the shows that are planned during the next several months. One of these shows may have considerably more interest for a child or a class than another.

Constructing a star box

You can replicate the feeling of being in a planetarium by making a star box out of a large empty refrigerator packing box that you can get from a shopkeeper.

Cut a door into one side of the refrigerator packing box. Devise a simple way to hold it shut, such as a strip of duct tape.

Paint the inside of the box black and let it dry thoroughly.

Choose favorite constellations and make accurate patterns of them. Then duplicate the patterns onto the inside walls and top of the box by using glow-in-the-dark pieces of tape for stars.

You can decorate the outside of the box in any fashion.

Cut a hole in the top of the box large enough to allow you to dangle a light that is attached to an extension cord that is long enough to reach a nearby electric outlet.

Put a stool or small chair inside the box. You can turn on the light just long enough to activate the glow tape, then turn out the light and sit inside the box. You will be surrounded by black space and glowing stars!

Watching the moon may also prove interesting. Many calendars will list the date of the next new moon, full moon, and crescent moons. During the new moon phase, the moon is between the sun and the earth with the lighted half of the moon away from the earth. The new moon is invisible, but a night or two after the new moon, you will be able to see the new crescent moon in the sky right after sunset. On each succeeding night, the moon appears higher and you will be able to see more of the surface until there is a full moon. The moon then begins to slowly fade again toward a new moon (waning crescent moon).

Only rarely will you and your curious child happen to be together in the right place during a lunar eclipse. If this were to occur, there would be considerable publicity about the event. Similarly you may happen to see a comet or the northern lights.

It's much more likely that your curious child may ask, "Why is the sky blue?" or "What is that ring around the moon?" These questions lead to more questions and investigations about how the clouds in our own atmosphere affect how we see the sky and moon in the distance. Clearly you would capitalize on such special events.

Answering the question: Why is the sky blue?

To answer the question, "Why is the sky blue?" you can do a simple experiment. Put a spoon in a full glass of water. Hold the glass up and look through it from the side. The spoon handle looks broken where it enters the water. This is due to the fact that light rays bend as they go from the thin air to the thicker liquid.

In the same way, light rays from the sun bend as they enter the earth's atmosphere and are scattered by the air and dust. Light rays from the sun are made up of all the colors of the rainbow. In our atmosphere, blue light is scattered most, so the sky looks blue.

Planets are another fruitful source of investigation. Planets do not produce light, they reflect sunlight, and so they must be close to us or very large to be seen. Mars, Venus, Jupiter, and Saturn can be seen easily. Charts are available that will let you know which planets can be seen in the evening or the early morning and where to look for them in the sky.

Modeling the planets

It is hard for students to conceptualize the sizes of the various planets. The following experiment explains a way to model the approximate sizes of the planets in a small space so that children can have some understanding of the sun and its family.

Label a basketball, which has a 10-inch diameter, "The Sun" and put it on a table.

Take a strip of wood about 1 foot long and 3 inches wide. Hammer nine, tall, thin nails into the strip of wood, equidistant from each other, with all but a ½ inch of the nail sticking upright from the wood. Put the strip of wood next to the basketball. Use strips of paper to write the names of the planets. Label each nail with the planet's name, beginning on the left with Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. (This will correctly show the order of the planets from closest to farthest from the sun but will not correctly show the distances.)

Make a model of each of the planets out of clay and put the model on the top of the nail with the correct label. Most of the planets will be very tiny. Mercury should be shown with a diameter of 1 mm; Venus, 2 mm; Earth, slightly more than 2 mm; Mars and Pluto, about 1½ mm; Neptune, about 5 mm; Uranus, about 6 mm; Saturn, about 13 mm; and Jupiter, about 16 mm.

If you like, you might make a cardboard ring to go around Saturn, holding it in place with toothpicks, stuck into the ball of clay.

Learning about the stars may be the most exciting part of sky watching. This, however, takes a cloudless night away from city lights. If a telescope is available, the opportunities will be increased. But even without a telescope, a child will enjoy finding constellations in the sky and will be able to see that some stars are "brighter" than others.

The Dipper Group has excellent stars for springtime viewing. A good summer group for observation are Cygnus, Draco, and Scorpio. The Pegasus group are good fall stars, and the Orion Group is a good cluster for winter viewing. In all seasons, you can study the Polar Group including the Big and Little Dipper and Cassiopeia.

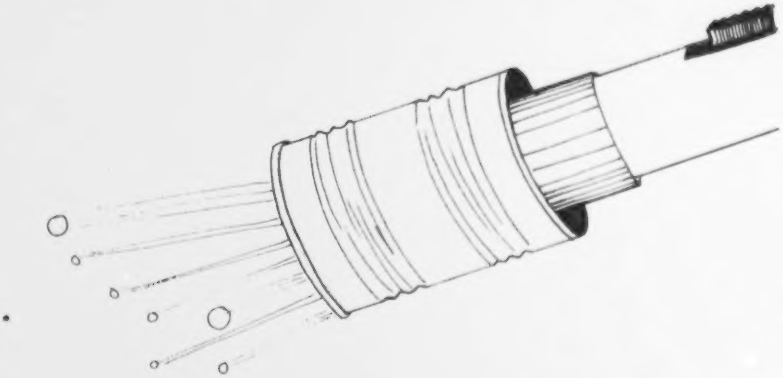
Projecting constellations

When a youngster knows a constellation well, he or she might draw it to scale on a small paper circle the size of a bottom of an empty tin can.

Tape the finished drawing to the bottom of the can. Use a hammer and a nail to puncture holes right through the drawing and into the can for each star. Use different sized nails; large ones to show bright stars and smaller ones to show not so bright stars.

Then, go into a dark room. Put a flashlight inside the can and turn it on.

You will be able to project the constellation onto the wall!



Watching the stars as they appear still in the sky is fun, but you and your curious child can also track a star with a camera as it travels in the night sky.

Clocking time exposure of star trails

If you have a camera with a time exposure adjustment, you may get a picture of star trails in the northern sky. Select a location away from city lights, on a dark night with little or no moon.

Mount the camera on a tripod and aim it at Polaris. Open the stop to its widest aperture, open the shutter, and leave it open for an hour.

Your photograph will show a circular star pattern.

Your class or a curious youngster might also be interested in comets and meteors. Many books are available on all these topics. Perhaps a museum in your area has a meteorite that you can view.

Sometimes sky watching leads to increased interest in space exploration and man-made satellites. This could open up a whole new area of exploration.

In addition to the resources listed below, you might want to consult the Resource books section in the following chapters for more specific details: Chapter 6 "Exploring Geology and Paleontology" for more information on meteorites, Chapter 8 "Exploring Geography and Cartography" for more on mapping and orienteering, and Chapter 12 "Exploring Science through Writing" for star legends.

Resource books

*_About Stars and Planets._ James Muirden. New York, NY: Warwick Press, 1986. 32 pp. Provides an introduction to stars and planets.

All about Stars. Lawrence Jefferies. Mahwah, NJ: Troll Associates, 1983. 31 pp. Answers many questions about the stars.

*_Amazing Space Facts._ Dinah L. Moche. Racine, WI: Western Publishing Co., 1988. 24 pp. Provides an introduction to the solar system.

Ancient Astronomy. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1989. 32 pp. Discusses the beliefs of early astronomers.

*_Anno's Sundial._ Mitsumasa Anno. New York, NY: Philomel Books, 1987. 28 pp. Discusses the earth and sun with pop-up and fold-out pages.

Apollo and the Moon Landing. Gregory Vogt. Brookfield, CT: Millbrook Press, 1991. 111 pp. Discusses the moon landing.

Astronomy. Dennis B. Fradin. Chicago, IL: Childrens Press, 1987. 286 pp. Provides basic information on stars, galaxies, and the universe.

Astronomy and Planetology. Nicia H. Apfel. New York, NY: Franklin Watts, 1983. 122 pp. Gives instructions for building and making simple planetariums and models of stars.

Astronomy: From Copernicus to the space telescope. Christopher Lampton. New York, NY: Franklin Watts, 1987. 96 pp. Explains the history and various theories in astronomy.

Big Dipper, The. Franklyn Mansfield Branley. New York, NY: HarperCollins, 1991. 32 pp. Contains basic information on how to determine position by using the North Star.

Big Dipper and You, The. Edwin C. Krupp. New York, NY: Morrow Junior Books, 1989. 48 pp. Gives information about the Big Dipper and the North Star.

Birth and Death of Stars, The. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1989. 32 pp. Tells how stars come into being and how they come to an end.

Comets and Meteors. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1990. 32 pp. Discusses characteristics and some of the more famous appearances of comets and meteors.

Comets and Meteors: Visitors from space. Jeanne Bendick. Brookfield, CT: Millbrook Press, 1991. 32 pp. Contains answers to many questions that children commonly ask about comets and meteors.

Cosmic Quest: Searching for intelligent life among the stars. Margaret Poynter. New York, NY: Atheneum, 1984. 124 pp. Explains the work of the SETI (Search for Extraterrestrial Intelligence) project.

Could You Ever Fly to the Stars? David Darling. New York, NY: Dillon Press, 1990. 59 pp. Discusses rockets, spacecraft, and the stars most likely for future destinations.

Day We Walked On the Moon, The: A photo history of space exploration. George Sullivan. New York, NY: Scholastic, Inc., 1990. 72 pp. Discusses astronauts and their training.

Destination: Moon. James Irwin with Al Janssen. Portland, OR: Multnomah, 1989. 50 pp. Explains the training of an astronaut.

Earth's Moon, The. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Gives many facts about the moon.

Exploring Venus and Mercury. David Baker. Vero Beach, FL: Rourke Enterprises, 1989. 47 pp. Chronicles the NASA space explorations.

Exploring with a Telescope. Glenn F. Chaple, Jr. New York, NY: Franklin Watts, 1988. 142 pp. Discusses the parts of telescopes, how they work, and how they should be cared for.

Exploring Your Solar System. Elizabeth Rathbun. Washington, DC: National Geographic Society, 1989. 96 pp. Provides a guided tour of the nine planets and discusses the Milky Way Galaxy.

Far Planets, The. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1991. 48 pp. Discusses the five known planets outside the orbit of Mars.

Galaxies, The: Cities of stars. David J. Darling. New York, NY: Dillon Press, 1985. 63 pp. Explains the different types of galaxies and how they formed.

Glow in the Dark Constellations: A field guide for young stargazers. C. E. Thompson. New York, NY: Grosset & Dunlap, 1989. 28 pp. Provides a useful resource to take outdoors at night when you are trying to spot constellations.

Glow-in-the-Dark Night Sky Book, The. Clint Hatchett. New York, NY: Random House, 1988. 20 pp. Provides star charts to consult at night.

Golden Book of Space Exploration, The. Dinah L. Moche. Racine, WI: Western Publishing Co., 1990. 45 pp. Traces the development of space travel.

Golden Book of Stars and Planets, The. Judith Herbst. Racine, WI: Western Publishing Co., 1988. 45 pp. Gives introductory information on stars and planets.

Halley's Comet: What we've learned. Gregory Vogt. New York, NY: Franklin Watts, 1987. 95 pp. Discusses the research carried out on Halley's Comet in 1986.

How Did We Find Out about Neptune? Isaac Asimov. New York, NY: Walker & Company, 1990. 64 pp. Provides information about the planet Neptune.

How Did We Find Out about Pluto? Isaac Asimov. New York, NY: Walker & Company, 1991. 64 pp. Introduction to the planet Pluto.

How Did We Find Out about the Universe? Isaac Asimov. New York, NY: Walker & Company, 1983. 64 pp. Offers an introduction to the study of the universe.

How Was the Universe Born? Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Discusses the origin of the universe.

I Can Be an Astronomer. Paul P. Sipiera. Chicago, IL: Childrens Press, 1986. 30 pp. Discusses the work that astronomers do.

Journey to the Planets. Patricia Lauber. New York, NY: Crown Publishers, 1990. 90 pp. Highlights the most prominent features of each of the planets.

Junk in Space. Richard Maurer. New York, NY: Simon & Schuster, 1989. 48 pp. Discusses space garbage.

Looking at Stars. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1991. 48 pp. Discusses various aspects of the stars.

Mars: Our mysterious neighbor. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Discusses the characteristics of the planet Mars.

**Moon, The.* Heather Cooper and Nigel Henbest. New York, NY: Franklin Watts, 1986. 32 pp. Provides an introduction to the moon.

Moon, The. David Hughes. New York, NY: Facts on File, 1989. 45 pp. Gives latest data about the moon.

Moon, The: A spaceflight away. David J. Darling. New York, NY: Dillon Press, 1984. 64 pp. Traces the evolution of our knowledge about the moon.

Moons and Rings: Companions to the planets. Jeanne Bendick. Brookfield, CT: Millbrook Press, 1991. 32 pp. Provides answers to common questions that children have about moons and rings.

**Moon Seems to Change, The.* Franklyn Mansfield Branley. New York, NY: Thomas Y. Crowell, 1987. 29 pp. Discusses the phases of the moon.

Moonwalk: The first trip to the moon. Judy Donnelly. New York, NY: Random House, 1989. 47 pp. Discusses the July, 1969, moon landing.

**My Picture Book of the Planets.* Nancy E. Krulik. New York, NY: Scholastic, Inc., 1991. 30 pp. Describes the nine planets and includes close-up color NASA photos.

Near Planets, The. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1991. 48 pp. Discusses the four planets closest to the sun.

Nebulae: The birth and death of stars. Necia H. Apfel. New York, NY: Lothrop, Lee & Shepard Books, 1988. 48 pp. Discusses how nebulae are formed.

Our Future in Space. Don Berliner. Minneapolis, MN: Lerner Publications Co., 1991. 71 pp. Discusses current space research and future space projects.

Our Solar System. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Discusses the characteristics of the sun, planets, and stars.

Our Sun and the Inner Planets. Don Davis and A. Chantal. New York, NY: Facts on File, 1989. 45 pp. Tells what astronomers know about the nuclear powerhouse that dominates our solar system.

Outer Space. Roger Cleeve. Englewood Cliffs, NJ: Julian Messner, 1990. 32 pp. Discusses various phenomena in our universe.

Out in Space. Tim Wood. New York, NY: Macmillan, 1991. 29 pp. Through a journey in a spaceship, the child learns about gravity, the moon, sun, and planets.

Peterson's First Guide to the Solar System. Jay M. Pasachoff. Boston, MA: Houghton Mifflin, 1990. 128 pp. Provides a basic guide to the solar system for beginners.

**Picture World of Sun and Stars, The.* Norman S. Barrett. New York, NY: Franklin Watts, 1990. 29 pp. Discusses our solar system, different types of stars, and galaxies.

Piloted Space Flights. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1990. 32 pp. Gives a history of mans' experiences in space.

Planets: A guide to the solar system. Mark R. Chartrand. Racine, WI: Golden Press, 1990. 160 pp. Presents information about the planets.

Power Station Sun. John Mason. New York, NY: Facts on File, 1987. 47 pp. Discusses the sun and energy.

Quasars, Pulsars, and Black Holes. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Discusses stars and galaxies emitting special types of radio waves.

Radio Astronomy. Alan Edward Nourse. New York, NY: Franklin Watts, 1989. 96 pp. Discusses the uses of radio astronomy.

Rainbows, Mirages, and Sundogs: The sky as a source of wonder. Roy A. Gallant. New York, NY: Macmillan, 1987. 94 pp. Discusses the various visual phenomena seen in the sky.

Rockets, Missiles, and Spacecraft of the National Air and Space Museum. Compiled by Gregory P. Kennedy. Washington, DC: Smithsonian Institution Press, 1983. 165 pp. Discusses holdings at the National Air and Space Museum.

Saturn. Dennis B. Fradin. Chicago, IL: Childrens Press, 1989. 45 pp. Discusses the main characteristics of Saturn and includes Voyager photographs.

Science for Kids: 39 easy astronomy experiments. Robert W. Wood. Blue Ridge Summit, PA: TAB Books, 1991. 139 pp. Provides information on experiments such as making a spectroscope and telescope.

**Shooting Stars.* Franklyn Mansfield Branley. New York, NY: Thomas Y. Crowell, 1989. 32 pp. Explains what shooting stars are.

So That's How the Moon Changes Shape. Allan Fowler. Chicago, IL: Childrens Press, 1991. 31 pp. Explains how the moon appears to change shape.

Space. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1990. 48 pp. Provides an introduction to space exploration.

Space and Astronomy: 49 science fair projects. Robert L. Bonnet and G. Daniel Keen. Blue Ridge Summit, PA: TAB Books, 1992. 128 pp. Provides a plethora of information about science fair projects.

Space Exploration. Brian Jones. Milwaukee, WI: Gareth Stevens Pub., 1990. 64 pp. Explains about space, stars, and the planets in our solar system.

Space Probes and Satellites. Heather Couper and Nigel Henbest. New York, NY: Franklin Watts, 1987. 32 pp. Discusses the development in both manned and unmanned space exploration.

Space Spotter's Guide. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Gives tips on buying a telescope and how to spot the wonders of the solar system.

Space: Stars, planets and spacecraft. Sue Becklake. New York, NY: Dorling Kindersly, 1991. 64 pp. Discusses outer space.

Space Telescope. Dennis B. Fradin. Chicago, IL: Childrens Press, 1989. 46 pp. Discusses existing telescopes and those that might be used in the future.

Space Telescope, The. Christopher Lampton. New York, NY: Franklin Watts, 1987. 70 pp. Discusses the history and goals of the Hubble Space telescope.

Star Guide. Franklyn Mansfield Branley. New York, NY: Thomas Y. Crowell, 1987. 51 pp. Discusses the composition and behavior of stars.

**Starry Sky, The.* Rose Wyler. Englewood Cliffs, NJ: Julian Messner, 1989. 32 pp. Discusses the sky, sun, stars, moon, and planets.

Stars and Planets. Patrick Moore. New York, NY: Exeter Books, 1987. 112 pp. A basic guide to stars and planets.

Stars, The: From birth to black hole. David J. Darling. New York, NY: Dillon Press, 1985. 64 pp. Explains the formation, life, and destruction of stars.

Stars, The: Lights in the night sky. Jeanne Bendick. Brookfield, CT: Millbrook Press, 1991. 32 pp. Provides an introduction to the stars.

Star Tales: North American Indian stories about the stars. Retold by Gretchen Will Mayo. New York, NY: Walker & Company, 1987. 96 pp. Contains a collection of Indian legends.

Starwatch. David Baker. Vero Beach, FL: Rourke Enterprises, 1989. 48 pp. Explains how astronomers use various tools to study the universe.

Sun, The. Denny Robson. New York, NY: Gloucester Press, 1991. 32 pp. Provides an introduction to the sun.

**Sun Is Always Shining Somewhere, The.* Allan Fowler. Chicago, IL: Childrens Press, 1991. 31 pp. Gives introductory information about the sun.

Sun, The: Our very own star. Jeanne Bendick. Brookfield, CT: Millbrook Press, 1991. 32 pp. Contains basic information on the sun.

Sun, Stars and Planets. Tom Stacy. New York, NY: Random House, 1991. 46 pp. Provides information about the sun, stars, and planets in question and answer format.

Superstar: The supernova of 1987. Franklyn M. Branley. New York, NY: Thomas Y. Crowell, 1990. 58 pp. Explains the nature and origin of a supernova.

Telescopes and Observatories. Heather Couper and Nigel Henbest. New York, NY: Franklin Watts, 1987. 32 pp. Discusses telescopes and major observatories.

Telescopes: Searching the heavens. Deborah Hitzeroth. San Diego, CA: Lucent Books, 1991. 96 pp. Discusses early astronomers and their tools and the development of telescope technology.

They Dance in the Sky: Native American star myths. Jean Guard Monroe and Ray A. Williamson. Boston, MA: Houghton Mifflin, 1987. 130 pp. Contains a collection of legends.

Uranus: The sideways planet. Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1988. 32 pp. Discusses the characteristics of Uranus as revealed by Voyager 2.

Venus. Dennis B. Fradin. Chicago, IL: Childrens Press, 1989. 45 pp. Explains the characteristics of the planet Venus.

Voyagers from Space: Meteors and meteorites. Patricia Lauber. New York, NY: Thomas Y. Crowell, 1989. 74 pp. Explains asteroids, comets, and meteorites.

What Is a Shooting Star? Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1991. 24 pp. Explains the differences between shooting stars and real stars.

Why Does the Moon Change Shape? Isaac Asimov. Milwaukee, WI: Gareth Stevens Pub., 1991. 24 pp. Explains the changes from crescent to full moon.

Other resources

The following magazines may be of interest: *Astronomy*; *The Astronomical Journal*; *Earth, Moon and Planets*; *The Mathematics Teacher*; *Science and Children*; *Science News*; *Scientific American*; and *Sky and Telescope*.

Astropilot (57–010–3036). Hudson, NH: Delta Education, Inc. Includes a 5-inch, celestial sphere featuring all 88 constellations, 868 naked eye stars, with light to make the stars glow in the dark. Includes full instructions. Uses batteries.

Comets. Franklyn Mansfield Branley. Old Greenwich, CT: Listening Library, 1987. 1 book, 32 pp. 1 sound cassette, 15 minutes. Tapekit. Gives information about comets.

Planets of the Sun. Leonard Nimoy (Narrator). Los Angeles, CA: Concord Video, 1985. 1 videocassette, 46 minutes. Discusses the planets and the sun.

Space Videos. Hudson, NH: Delta Education, Inc. The Apollo Program (57–220–0879), 30 minutes. America in Space (57–220–0868), 50 minutes. Space Shuttle Pioneers (57–220–0846), 60 minutes. The Universe (57–220–0857), 30 minutes.

Zoom Telescope/Spotting Scope (57–200–4321). Hudson, NH: Delta Education, Inc. Features quality 50 mm zoom lens.

Stellarscope (57–191–2657). Hudson, NH: Delta Education, Inc. This device shows 1500 stars of up to 5th magnitude.

8

Exploring geography and cartography

Exploring geography and cartography can take many forms. An interest in a state or country might encourage a child to study its mountains and valleys. Putting together a rock collection might lead a child to want to visit a certain rock formation to collect a specimen. Setting out on a camping or fishing trip, going on a hike, or planning a biking trip can create a real sense of exploration and establish the need to know more about geography. Developing a good working knowledge of map reading is a plus in any of these activities.

There are many times when hiking, as a pleasure of its own or in conjunction with another interest, is a good pursuit for adults and children. A hike might consists of a short walk with a class of students from a school to a nearby park, a weekend backpack trip with a child and adult, or a major outing with a scout group. For anything other than a brief hike in town, considerable preplanning is necessary.

Hiking requires attention to your current physical condition, to appropriate clothing (especially shoes), to equipment, and to appropriate routes and destinations. "Easy does it" is a good motto to have when beginning a season of hiking with a child or setting out on a hike with a group of children. This advice is for the adult as well as the child! Start with relatively short distances on trails that do not have sharp gains in elevation. Some of those muscles that feel fine while you are walking might be stiff and sore the next day if you are not in shape. Gradually you can increase the distance that you travel and can tackle more difficult trails.

Perhaps the single most important factor in a comfortable hike is your selection of shoes and socks. While sneakers might be appropriate for a short hike on a dirt trail in the woods, good boots and socks are necessary to protect feet and ankles on longer hikes or on rougher terrain. A hat, sunscreen, comfortable pants or hiking shorts, and a loose-fitting shirt are also requirements. Remember that the weather is continually changing, so it's a good idea to be able to add or remove a layer of clothing.

Equipment should include a frame-pack for long trips or a day-pack for short hikes to allow you to carry rain gear, a jacket, food, water, first-aid supplies, a compass, and maps. If a group of children is involved in a hike, a list of required supplies and attire should be sent to parents. What should not be brought along should also be stressed in your note to the parents.

Finding a safe and interesting place for your hiking can present a challenge. Those who live in urban or suburban settings seem to have been driven from the paths and streets by the automobile, while a few shopping malls have included marked distances for walkers. Likewise, many urban planners are including open space for hiking and bike paths. There is also a movement in our country to establish a network of trails and paths.

Don't overlook the interesting sights that can be seen on a walk in a town or city. There may be maps of historic sites to visit, a trip to the docks to consider, or an "old town" section that will be fascinating to explore. Walking on cement is especially tiring, and you will need to pace yourself so as to not get worn out. Remember, young children have a shorter stride than an adult and may tire more quickly.

Determining your walking speed

Finding out the speed at which a child walks and the length of his or her normal stride is interesting and will let you estimate how long it will take to cover a trail.

Measure the distance between two points and convert that distance into inches. Then count the number of strides a child uses to cover that distance. Divide the inches by the number of strides and you will learn the length of the child's normal stride.

If you time the child, you will have a rough idea of how far the child will walk during a given time period if he or she continues at the same stride and pace.

You might plan a hike in connection with another interest or class activity; for example, spotting birds or wildflowers. Maybe you want to go to an area to take photographs. Perhaps your hike will lead you to identify trees or minerals. You may want to do some fishing or do some beachcombing. These and many more activities are compatible with hiking.

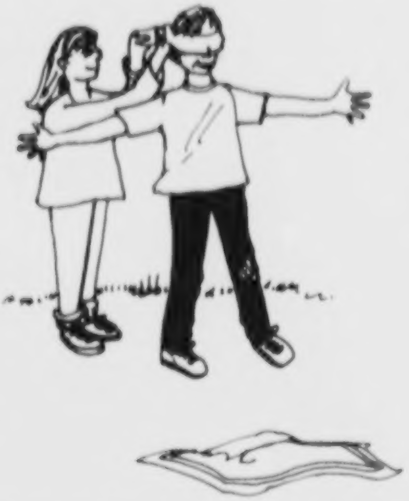
Should you live in the right section of the country, you may be close to a really big hiking trail that is completed or still under construction. The best known trail is the Appalachian Trail, which extends 2000 miles from Mt. Katahdin, Maine, to Springer Mountain, Georgia. The Pacific Crest Trail stretches 2,300 miles from the Washington-Canadian border to the California-Mexican border. The completed Continental Divide Trail will stretch from the Montana-Canadian border to Silver City, New Mexico. The Lewis and Clark Trail is being developed to stretch 4,600 miles from St. Louis, Missouri, to the mouth of the Columbia River. The Potomac Heritage Trail passes 825 miles from the mouth of the Potomac River to its sources in Pennsylvania and West Virginia. Long Trail in Vermont is a 250 mile trail.

Whenever you are out in the woods, there is a possibility of being lost. Remember to plan ahead of time in detail exactly what to do if you get separated from the group. Knowing how to read maps and use a compass will help you get oriented. Some people believe they have a perfect sense of direction, but they may be wrong. The following experiment can help you test your sense of direction.

Testing your sense of direction

To test one's sense of direction, try the following in a park or playing field where you can walk for 50 yards on relatively flat, grassy ground.

Place a handkerchief on the ground 50 paces away. Put a good blindfold over the eyes of the person you are testing. Ask the person to walk 50 paces directly to the handkerchief. How close did the person come? Give the person three tries and mark each attempt.



Although children need to be given instructions on what to do if they get lost, it is of course most desirable not to get lost in the first place! One way to avoid being lost is to learn to use a compass. This is not as easy as it might seem. North and magnetic north are not the same. You can buy a compass that can be adjusted for declination, which is the value in degrees between magnetic north and true north. The following experiment will help you sharpen your skills in using a compass.

Using a compass

First align your compass with the needle pointing to magnetic north. Then, select a bearing such as 45 degrees, northeast. To follow a chosen bearing, sight along an imaginary line running from the center of your compass across the 45-degree mark to some prominent and easily recognizable natural feature, such as a tree or cliff. Try to keep it in sight as you move toward it. To return, sight another object, which is 180 degrees in the opposite direction, or 225 degrees, southwest. Then proceed toward the new object.

Once you have learned to use a compass, you can rely on it. But remember that its needle can be thrown off if it is near a large mineral iron ore deposit or even by a steel axe that you are carrying.

You can buy topographic maps of most areas. Using such a map along with a compass is a much better way to navigate. (Remember to orient your compass using the arrows on the map that indicate both magnetic north and true north.)

Wherever you live, there may be a local hiking club or at least one that is not far away. Checking with these club members may enable you to join in their activities and hikes. Many groups publish a newsletter with a schedule of planned activities. Some of these clubs secure permission to hike in areas that might not be open to individual hikers. Members of the club might also be willing and available to visit a class of students and discuss various aspects of hiking.

As in hiking, biking also requires you to put "safety first." A child (or adult) on a bicycle must always wear a well-fitting, approved helmet while on a bicycle trip. Although bicycles come in many styles and types, it is essential that the bike that is being used be the right size for the child riding it.

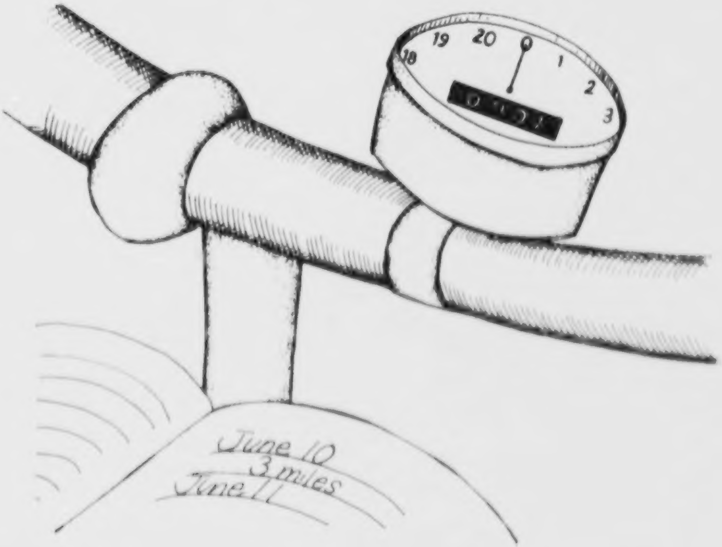
In addition to the helmet, appropriate shoes and a long-sleeved shirt or sunscreen should also be worn to prevent discomfort. Carrying a first aid kit, a supply of water, and minimum equipment for simple on-the-road repairs should be included on any bicycle expedition.

If you are a newcomer to biking, one of the best sources of information may be your local bike shop. Knowledgeable store personnel can put you in touch with local cycling groups and share maps of bike paths and routes.

If you are interested in keeping track of the distance you travel on a bike trip and your speed, you can use an odometer or cyclocomputer. These give you a very good idea of your speed and distance. The following experiment will help you learn to use your bicycle odometer.

Using a bicycle odometer

Your bike shop will have a number of odometers or cyclocomputers. Depending on the model you get you will be able to get speed, average speed, maximum speed, elapsed time, trip distance, and other pertinent information.



Attach an odometer to your child's bike. Have the child keep a cycling diary in which he or she records your bike trips. Include the data from the odometer. If this is continued over a period of time, the child should see an increase in speed and endurance.

Whether you are considering short walks, long hikes, or bike trips, map reading skills are important. Depending on the child's age and understanding of geography, skills in map-making and map-reading will vary considerably. An adult can do a great deal to build these skills.

One way to demonstrate that geography is a way of thinking and observing, is to help build a vocabulary and precise mental images of places and directions for your child. For example, try saying, "We are going south to Texas to visit Grandma," rather than saying, "We are going down to Texas to visit Grandma." Use words such as desert, glacier, climate, and so forth when describing areas. This will build up a language for geography.

Even very young children can learn to read a map. You might go for a neighborhood walk and then show the child a street map of your town, showing him or her the streets you have walked together. You might point out where friends or relatives live. Older children may be interested in topographic maps of an area in which they are planning a hike. Topographic maps are created and sold by the United States Geological Survey.

Playing the party map game

Middle grade students might find this an interesting challenge as a party game. Have children divide themselves into groups of two or three. Give each group a copy of the same state map. Ask them to write down the names of the cities that they'd visit and the highways that they'd travel to get from point A to point B, from point C to point D, and from point E to point F.

Choose destinations that have several different routes leading to them. Ask the teams to find the fastest and shortest routes.

Offer a prize to the team that can solve the map challenge first.

Students also need to learn some skills about reading a globe. Help a child or a class of students examine a globe and find the lines of longitude (lines that run from the North Pole to the South Pole, from 0 degrees, through Greenwich, England—the prime meridian, to 180 degrees east and around the globe back to 0 degrees again). Since the sun moves over 15 degrees of the earth's surface every hour, for each 15 degrees west of Greenwich, the time is set back one hour.

Finding out what time it is in different parts of the world is an interesting activity. The following experiment can help you "determine time" around the globe.

Determining time

Use a plastic globe with a slick surface. Have the child or group of students find the line 15 degrees west of Greenwich, England. Tape a colored skinny strip of paper with the numeral "1" on it to this line. Then tape a strip of paper with the numeral "2" on it to the line that is 30 degrees west of Greenwich.

Continue taping strips of paper every 15 degrees around the globe. Number "12" should be on the 180-degree line. This line is the International Date Line. It is 12 hours behind Greenwich time. If you cross this line going west, you lose a day. Traveling east, you gain a day.

When you pass the International Date Line, number the line 15 degrees past it with a number "1." Continue numbering every 15 degrees until you get back to Greenwich, England, and put your number "12" there.

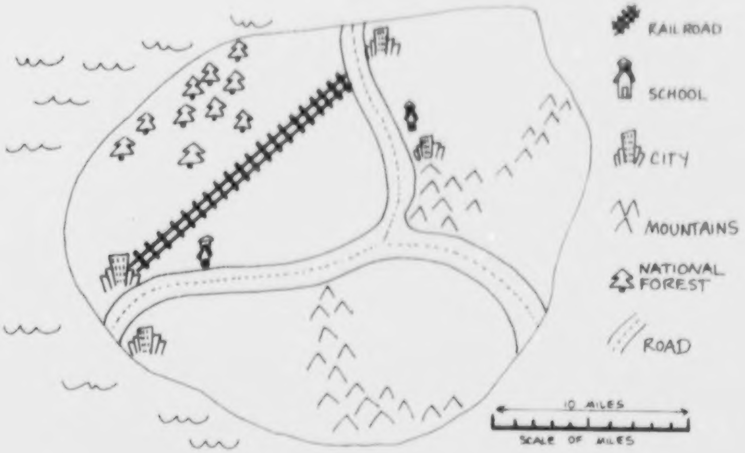
Now by locating a city or country, and checking the strips of paper taped to your globe, you can add or subtract to find what time it is there.

Making a map is quite a different experience from reading one. You might want to begin your class or your child's study of geography by making a map of one room in your house. Trying to draw it correctly to size will be a challenge. Older children might pace off or do some rough measurements and try to draw their maps to scale.

Looking at a road map will quickly lead to a discussion of map symbols. You will need to spend some time examining and understanding symbols, which may indicate campgrounds, parks, and schools; size of print or color designations which indicate the size of a city or the type of a road; and other specifics of a map. When such symbols and details are learned, help your child put the new knowledge to use by creating his or her own map.

Mapping an imaginary island

Help the child make a map of an imaginary island. Symbols should be used to indicate the location of mountains, major cities or towns, railroad tracks, national forests, and other important items. There should be a key that also indicates the scale of miles.



This map can be as simple or complex as the child has interest in making it. The important outcomes are demonstrating an understanding of using a map key or legend and determining a scale of miles.

Few explorations offer as much fun to adults and curious kids alike as a camping and/or fishing trip. To be successful, considerable preplanning is required, including preparing for a lot of "what if's." For example, what if it rains? What if we don't catch any fish to eat?

What if all the campsites are taken in one desirable location? What if someone falls in the water or gets lost?

Experienced campers have already learned about some of the mishaps that can befall a camper when car camping or backpacking and have planned how to avoid them or work around them. If you're a beginner, the one thing you can count on is the unexpected!

Realize that weather is ever changing and plan to have enough of different kinds of clothing so that you and your curious child or class of students will be comfortable. Shivering around the campfire in wet shoes or getting a bad sunburn from exposed skin in mountain sunshine can lead to a lot of discomfort.

Plan on extra food. It's amazing how appetites seem to increase with activity in the open air—and don't count on having plenty of fresh trout to cook. If you're backpacking, weight and quantity of food are a major consideration, but don't skimp. If you are car camping, it's better to cart back home some canned and packaged goods that you didn't use than it is to find yourselves hungry and out-of-sorts on the trip.

Unless you know that drinking water is available, you also need to provide plenty of liquids for drinking. Be sure not to drink any water unless you are certain that it is safe. If you are backpacking, you will need to take along a filter or tablets to make the water safe for drinking.

When going on a camping/fishing trip, the only thing better than Plan A is Plan A backed up by Plan B. You may find that a road has been closed or that a favorite area is suddenly filled with people on a family reunion. Having an alternative in mind that is almost equally as good as the most desirable destination is a great idea!

If you don't camp often, you may want to do a dry run at home or at school to be sure that you really can quickly set up your tent. Tents vary greatly—from the spacious cabin tent you may use for car camping to a small two-person tent carried in a backpack. Ropes, tarps, stakes, poles, and ground covers are all a part of the process.

The printed directions that come with a new tent don't always seem to correspond with the number of interlocking poles, ropes, and canvas that you find sitting in front of you at a campsite as storm clouds gather above and hungry children simultaneously demand to be fed. A quick practice at home or school will allow you to set up your tent confidently in a minimum amount of time.

Even though you may be sleeping in a tent, take time to enjoy a good look at the stars (see Chapter 7 "Exploring Astronomy"). Away from the lights of a city, the sky can be especially beautiful. You can probably find a few favorite constellations in the sky. This is also a great time to recite some of the constellation stories and legends.

Telling star stories

Why not make up your own story about the stars? Pick out a group of stars that seem to make a picture in the sky. Think of a story that might explain what you see.

For example, you may see a cluster of stars that resemble a bird with its wings outspread. Perhaps the bird was a seagull that guided one of the Greek Gods to shore when he was lost one night on a wind-tossed sea. The grateful God then put the helpful bird up in the sky so that he could guide other lost and weary travelers at night.

Each person on your camping outing might find a star cluster, make up a story, and then share it with the others.

A folding table, a fly to cover the cooking/eating area, and simple, dependable lanterns and stoves will help you enjoy your car camping experience. You may find that everything at your campground in the woods is dry and there is plenty of firewood readily available for your campfire. There may be tables and benches and a metal or cement barbecue area for a cooking pit. But if some of these ideal conditions are lacking, having back-up could save the day.

You need warm sleeping bags, flashlights with "new" batteries, a mosquito repellent, and sunscreen lotions. Another must is a well-supplied first aid kit.

Plan for emergencies. If you are going to be near water, be sure to review water safety. Children also need to be advised of what to do if they believe they are lost. Supply them with a whistle to blow should they become lost or hurt and need to alert others to come to their rescue. Taking along a big scale map of the area and a compass is an excellent idea. Taking a compass reading and getting oriented right after arriving in camp is time well spent.

Using a wristwatch as a compass

Between the hours of six in the morning and six at night, you can use a wristwatch much as you would a compass to roughly tell direction.

Point the hour hand at the sun while holding the watch face-up, flat in your hand. Halfway between the hour hand and the 12 lies south in the northern hemisphere. (If you are on daylight saving time, south is half-way between the hour and the 1.)

If you are going to fish, you need to be sure that all of your equipment is ready. This includes a check of your boat (if you are using one), rods, reels, lines, hooks, lures, flies, bait, and other needed tackle. Be sure that you are familiar with fishing license requirements and the various regulations in the area so that you can obey them.

If you are hiking into a fishing area, be sure to wear good hiking boots. If you are going to be in a boat, sneakers or soft-soled shoes are important. A pair of sunglasses and a wide-brimmed hat are good items to have in a boat for protection from sun and glare off the water.

Knowing a variety of simple knots used in fishing is a plus. At home you and your curious kid, or at school, a classroom of students, can practice such knots as: blood or barrel knot for tying monofilament, clinch knot, square knot, figure eight knot, and other simple knots.

After all this preplanning, you are ready to go off on your exploration and enjoy yourselves! For your first adventure, you might want to plan a one-night trip. You'll learn a lot from this experience. Then you might want to try a longer trip.

One of the joys while out on a camping/fishing trip is observing birds and animals (see Chapter 5 "Exploring Ethology"). You should not try to touch wildlife, however, because animals can become frightened and bite, and they may carry diseases. But you might toss them a nut or cracker and watch them from a distance.

If you are lucky enough to see wildlife, you may want to sketch what you find and see and add these drawings to your notebook, along with the date, time, and location of the sighting (see Chapter 13 "Exploring Science through Art").

Learning to "freeze"

Some animals have learned to "freeze" when they sense an enemy. Learning to "freeze" is a good skill for a camper in the woods who has spotted a bird or animal. Staying very still may encourage the creature not to run away; thus, it may continue with its activities.

Some animals are curious and you might be able to lure them out into the open. For example, tapping on the trunk of a dead tree that has hole in it where you suspect birds or animals may be hiding might cause them to come to an opening and look out. Similarly, lightly tapping two stones together might cause a squirrel or chipmunk to come watch what you are doing.

After packing all your things back up after a successful camping/fishing trip, remember that you have one more responsibility—be sure to leave your campsite neat and clean. Be sure that any fire you have made is completely out. This is an excellent time to help a child or a class learn about responsibility for the environment.

Whether you go for a short hike from school, ride along a city bike path, take a major hike in the mountains, or go off on a camping or fishing trip, there will be an opportunity to use map skills and to observe many things along the way. Other chapters in this book that may be of particular interest include: Chapter 4 "Exploring Botany," Chapter 5 "Exploring Ethology," Chapter 6 "Exploring Geology and Paleontology," Chapter 9 "Exploring the Watery World," Chapter 10 "Exploring the Ocean," and Chapter 13 "Exploring Science through Art".

Resource books

Animal Atlas, The. Barbara Taylor. New York, NY: Alfred A. Knopf, 1992. 64 pp. Shows the different habitats and animals that live there.

Anybody's Bike Book: An original manual of bicycle repairs. Tom Cuthbertson. Berkeley, CA: Ten Speed Press, 1990. 215 pp. Provides a manual for help in making bicycle repairs.

*_As the Crow Flies: A first book of maps._ Gail Hartman. New York, NY: Bradbury Press, 1991. 32 pp. Provides a look at different geographic areas from the perspectives of an eagle, rabbit, crow, horse, and gull.

Atlas of Today: The world behind the news. Jon Snow. New York, NY: Warwick Press, 1987. 61 pp. Good tool for use in discussing world events.

Backpacking. Boy Scouts of America. Irving, TX: Boy Scouts of America, 1983. 80 pp. Gives general hiking techniques and discusses equipment and first aid.

Bicycles Are Fun to Ride. Dorothy Chlad. Chicago, IL: Childrens Press, 1984. 31 pp. Tells a story of a boy and his enjoyment of riding a bike and discusses safety rules.

Bicycle Racing. Nancy J. Nielson. Mankato, MN: Crestwood House, 1988. 48 pp. Discusses racing strategy and different types of bikes used in racing.

Bicycling Magazine's Complete Guide to Bicycle Maintenance and Repair. Editors of *Bicycling*. Emmaus, PA: Rodale Press (distributed by St. Martin's Press), 1990. 310 pp. Provides a complete bicycle repair guide.

Bikes. Anne Rockwell. New York, NY: Dutton, 1987. 24 pp. Discusses different bikes such as the unicycle, tandem bike, racing bike, trail bike, and exercise bike.

**Bike Trip.* Betsy and Giulio Maestro. New York, NY: HarperCollins, 1992. 32 pp. Describes a family on a bike trip.

BMX Bikes. Norman S. Barrett. New York, NY: Franklin Watts, 1987. 32 pp. Describes bikes, riding techniques, and bicycle motorcross racing.

BMX Freestyle. Larry Dane Brimner, New York, NY: Franklin Watts, 1987. 72 pp. Offers an introduction to stunts and routines performed on motorcross bicycles.

BMX'S. Paul Estrem. Mankato, MN: Crestwood House, 1987. 47 pp. Provides an introduction to the sport of bicycle motorcross.

Camping and Orienteering. Michael Jay. New York, NY: Warwick Press, 1990. 40 pp. Offers a guide to planning a camping trip with tips on reading maps.

Camping and Walking. David Watkins and Meike Dalal. Tulsa, OK: EDC Pub., 1989. 128 pp. Discusses camping, hiking, and walking.

Camping Basics. Wayne Armstrong. Englewood Cliffs, NJ: Prentice-Hall, 1985. 48 pp. Describes skills and equipment needed to camp safely.

Camping in the Temple of the Sun. Deborah Gould. New York, NY: Bradbury Press, 1992. 32 pp. Describes the fun and mishaps on a family's first camping trip.

* *Camping Out: A book of action words.* Betsy and Giulio Maestro. New York, NY: Crown Publishers, 1985. 32 pp. Provides labeled illustrations of backpacking, fishing, and hiking.

* *Camping Safety.* Sally McNulty. Vero Beach, FL: Rourke Enterprises, 1984. 32 pp. While camping with the beaver family, Moonbird discusses camping safety.

Children's Atlas of World Wildlife. Elizabeth G. Fagan. Chicago, IL: Rand McNally, 1990. 93 pp. A zoogeography.

Children's Space Atlas, The: A voyage of discovery for young astronauts. Robin Kerrod. Brookfield, CT: Millbrook Press, 1992. 95 pp. Discusses gathering information and mapping the solar system and space.

Cycling. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1991. 32 pp. Tells a story of a boy who learns to ride and fix a tire. Also gives highlights of the Tour de France.

Colorado Cycling Guide. Jean and Hartley Alley. Boulder, CO: Pruett Publishing Co., 1990. 377 pp. Contains route maps, city maps, sources of food and lodging, and information on clubs, publications, and source materials for bicyclists.

Doubleday Picture Atlas, The. Wendy Roebuck. New York, NY: Doubleday, 1988. 61 pp. Provides maps, background information, and discusses geographical features of countries of the world.

Eastern Great Lakes: Indiana, Michigan, Ohio. Thomas C. Aylesworth and Virginia L. Aylesworth. New York, NY: Chelsea House Publishers, 1991. 64 pp. Discusses the geography, history, and cultural aspects of Indiana, Michigan, and Ohio. Includes maps.

Everything Is Somewhere: The geography quiz book. Jack McClintock and.David Helgren. New York, NY: Morrow Junior Books, 1986. 160 pp. Contains 30 quizzes about countries.

Explorers and Mapmakers. Peter Ryan. New York, NY: Dutton, 1990. 48 pp. Discusses early explorers and their maps.

Facts on File Children's Atlas, The. David and Jill Wright. New York, NY: Facts on File, 1987. 96 pp. Provides a useful children's atlas.

Fish in a Flash!: A personal guide to spin-fishing. Jim Arnosky. New York, NY: Bradbury Press, 1991. 63 pp. Offers an introduction to fishing with spin lures.

Fishing. Bruno Broughton. New York, NY: Bookwright Press, 1991. 32 pp. Describes techniques of fishing and safety features.

Fishing for Fun: A freshwater guide. Charles P. and George F. Roberts. New York, NY: Dillon Press, 1984. 155 pp. Provides an introduction to fishing equipment, bait, lures, and knots.

**Fishing with Cap'n Bob and Matey: An encyclopedia for kids of all ages.* Lew Hackler. Colonial Heights, VA: Seascape Enterprises, 1990. 32 pp. Consists of a glossary of boating terms for beginners.

Fishing with Small Fry: How to hook your kids on fishing. Bob Ellsburg. Portland, OR: Flying Pencil Pub., 1991. 119 pp. Describes how to introduce children to fishing.

**Fishy Shape Story, A.* Joanne and David Wylie. Chicago, IL: Childrens Press, 1984. 27 pp. While describing a fishing adventure, a child introduces fish of different shapes such as triangles, squares, and so forth.

Food from the Sea. Daniel Rogers. New York, NY: Bookwright Press, 1991. 32 pp. Discusses fish, types of fishing, and fish farming.

Freshwater Fishing. Katherine Jarman. Morristown, NJ: Silver Burdett Press, 1988. 63 pp. Discusses the history, equipment, tactics, and recent developments in freshwater fishing.

Glacier National Park. Ruth Radlauer. Chicago, IL: Childrens Press, 1984. 48 pp. Discusses the sheep and glaciers of the park along with information about hiking and camping.

Globes. Paul Sipiers. Chicago, IL: Childrens Press, 1991. 45 pp. Explains the usefulness of globes.

Great Dinosaur Atlas, The. William Lindsay. Englewood Cliffs, NJ: Julian Messner, 1991. 64 pp. Provides a guide to the prehistoric world of dinosaurs. With maps.

Great Plains, The: Montana, Nebraska, North Dakota. Thomas G. Aylesworth and Virginia L. Aylesworth. New York, NY: Chelsea House Publishers, 1988. 64 pp. Discusses the geography, history, and cultural aspects of Montana, Nebraska, and North Dakota. Includes maps.

Great World Atlas, The. The American Map Corporation. Tucson, AZ: Zephyr Press, 1989. 384 pp. Includes a section on the Nature of Our Planet and the Nature of Our Universe.

Greg LeMond: Premier cyclist. A. P. Porter. Minneapolis, MN: Lerner Publications Co., 1990. 64 pp. Tells of the training and courage needed by Greg LeMond, the first American to win the Tour de France.

Help Is on the Way for Maps and Globes. Marilyn Berry. Chicago, IL: Childrens Press, 1985. 46 pp. Helps in map skills development.

How to Make and Repair Your Own Fishing Tackle: An illustrated step-by-step guide for the fisherman and hobbyist. Jim Mayes. New York, NY: Dodd, Mead, 1986. 172 pp. Tells how to make and fix fishing tackle.

How to Use Maps and Globes. Helen W. Carey. New York, NY: Franklin Watts, 1983. 83 pp. Explains how maps are designed and how they are used.

Hudson River: An adventure from the mountains to the sea. Peter Lourie. Honesdale, PA: Caroline House (distributed by St. Martin's Press), 1992. 47 pp. Offers an account of a 315-mile canoe trip down the Hudson River with color photos and maps.

**I Can Ride a Bike.* Sheila Fraser. New York, NY: Barron's, 1991. 21 pp. Tells of a young girl who overcomes her fear of riding a bike.

Illustrated World Atlas. David and Jill Wright. New York, NY: Warwick Press, 1987. 64 pp. Provides an illustrated atlas of the world.

In the Water—On the Water. Dorothy Chlad. Chicago, IL: Childrens Press, 1988. 31 pp. Gives pointers to readers on water safety.

**Just Camping Out.* Mercer Mayer. Racine, WI: Western Publishing Co., 1989. 23 pp. Presents a golden picture book about camping.

Kids' Book of Fishing, The. Michael J. Rosen. New York, NY: Workman Pub., 1991. 96 pp. Discusses a variety of basic techniques and equipment for the beginner fisherman.

Learn How to Fly Fish in One Day: Quickest way to start tying flies, casting flies, and catching fish. S. Nemes. Harrisburg, PA: Stackpole Books, 1986. 124 pp. Provides information about all aspects of fly fishing.

Let's Go Fishing. Jan Wahl. Racine, WI: Western Publishing Co., 1987. 24 pp. Presents a big, little Golden book on fishing.

Let's Go Fishing! A book for beginners. Gerald D. Schmidt. Niwot, CO: Roberts Rinehard, Inc., 1990. 85 pp. Offers an introduction to fishing.

Mapmaking. Karin N. Mango. Englewood Cliffs, NJ: Julian Messner, 1984. 106 pp. Explains map symbols and the techiques of making maps. Gives a brief history of mapmaking.

Maps and Globes. Ray Broekel. Chicago, IL: Childrens Press, 1983. 45 pp. Discusses different types of maps, their keys, symbols, and scale.

Maps and Globes. Jack Knowlton. New York, NY: Thomas Y. Crowell, 1985. 42 pp. Provides a brief history of mapmaking and instructions on how to read maps and globes.

Maps and Globes. David Lambert. New York, NY: Bookwright Press, 1987. 32 pp. Gives an introduction to maps and globes.

Maps and Globes: Fun, facts, and activities. Caroline Arnold. New York, NY: Franklin Watts, 1984. 32 pp. Gives instructions to make a balloon globe, a room model, a contour map, and a treasure map.

Maps: Getting from here to there. Harvey Weiss. Boston, MA: Houghton Mifflin, 1991. 64 pp. Explains such things as map symbols, latitude, longitude, and special purpose maps.

Measuring and Maps. Keith Lye. New York, NY: Gloucester Press, 1991. 32 pp. Explores the science of geography with globes, maps, symbols, and suggested projects.

Mountain Biking. Tim Wood. New York, NY: Franklin Watts, 1989. 32 pp. Provides an introduction to mountain biking.

* *My First Atlas.* Pamela Mayo. Newmarket, Eng.: Brimax Books, 1989. 45 pp. A introductory atlas for children aged 4–7.

* *My Summer Vacation.* Sumiko. New York, NY: Random House, 1990. 30 pp. Describes a little girl's camping trip.

Northern New England: Maine, New Hampshire, Vermont. Thomas G. Aylesworth and Virginia L. Aylesworth. New York, NY: Chelsea House Publishers, 1991. 64 pp. Discusses the geography, history, and cultural aspects of Maine, New Hampshire, and Vermont. Includes maps.

Olympia National Park. Ruth Radlaver. Chicago, IL: Childrens Press, 1988. 48 pp. Describes the physical features, plants, animals, and camping accommodations in Olympia National Park.

People Atlas, The. Philip Steele. New York, NY: Oxford University Press, 1991. 64 pp. Explores the people of the world through text and map spreads.

Picture Atlas of the World. Roy Woodcock. New York, NY: Derrydale Books (distributed by Crown Publishers), 1987. 96 pp. Offers a picture atlas.

Picture World of BMX, The. R. J. Stephen. New York, NY: Franklin Watts, 1989. 29 pp. Describes BMX bikes, equipment, skills, tricks, and races.

Pocket Guide to Bicycle Maintenance and Repair. Greg LeMond. New York, NY: G.P. Putnam's Sons, 1990. 119 pp. Provides a handy guide to bike maintenance and repair.

Puzzle Maps U.S.A. Nancy L. Clouse. New York, NY: Henry Holt, 1990. 32 pp. Provides a series of simple puzzle maps of all 50 states.

Riddle King's Camp Riddles, The. Mike Thaler. New York, NY: Random House, 1989. 32 pp. Contains riddles about camping.

Roadside Bicycle Repairs: The simple guide to fixing your bike. Rob Van der Plas. New York, NY: Talman Co., 1990. 126 pp. Explains how to repair your bicycle.

Safety First—Bicycle. Cynthia Fitterer Klingel. Mankato, MN: Creative Education, 1986. 27 pp. Discusses bicycle safety.

Science for Kids: 39 easy geography activities. Robert W. Wood. Blue Ridge Summit, PA: TAB Books, 1992. 141 pp. Provides an introduction to the science of geography through activities.

Sierra Club Wayfinding Book, The. Vicki McVey. Boston, MA: Little, Brown, 1988. 88 pp. Explains how humans get around using their senses, landmarks, signs, and maps.

South, The: Alabama, Florida, Mississippi. Thomas C. Aylesworth and Virginia L. Aylesworth. New York, NY: Chelsea House Publishers, 1988. 64 pp. Discusses geography, history, and cultural aspects of Alabama, Florida, and Mississippi. Includes maps.

Southwest, The: Colorado, New Mexico, Texas. Thomas G. Aylesworth and Virginia L. Aylesworth. New York, NY: Chelsea House Publishers, 1992. 64 pp. Discusses the geography, history, and cultural aspects of Colorado, New Mexico, and Texas. Includes maps.

Take a Hike! The Sierra Club kids' guide to biking and backpacking. Lynne Foster. Boston, MA: Little, Brown, 1991. 176 pp. Tells how to prepare for and enjoy hikes and backpack trips.

**Treasure Hunt, The: A story about geography and maps.* Liza Alexander. Racine, WI: Western Publishing Co., 1990. 32 pp. Describes how Big Bird and Elmo of Sesame Street television go on a treasure hunt using a map.

Two Hundred Years of Bicycles. Jim Murphy. New York, NY: J.B. Lippincott, 1983. 64 pp. Gives a history of bicycles from 1791 to the present.

United States Atlas for Young People. Kathie Billingslea Smith. Mahwah, NJ: Troll Associates, 1991. 128 pp. Provides a map for each state and U.S. possession.

Upper Atlantic: New Jersey, New York. Thomas G. Aylesworth and Virginia L. Aylesworth. New York, NY: Chelsea House Publishers, 1990. 64 pp. Discusses the geography, history, and cultural aspects of New Jersey and New York. Includes maps.

Warwick Atlas of World History, The. Jane Olliver (Editor). New York, NY: Warwick Press, 1988. 93 pp. Provides an atlas of history.

West, The: Arizona, Nevada, Utah. Thomas C. Aylesworth and Virginia L. Aylesworth. New York, NY: Chelsea House Publishers, 1992. 64 pp. Discusses the geography, history, and various cultural aspects of Arizona, Nevada, and Utah. Includes maps.

Western Great Lakes: Illinois, Iowa, Minnesota, Wisconsin. Thomas G. Aylesworth and Virginia L. Aylesworth. New York, NY: Chelsea House Publishers, 1992. 64 pp. Discusses the geography, history, and cultural aspects of Illinois, Iowa, Minnesota, and Wisconsin. Includes maps.

Wheels!: The kids' bike book. Megan Stine. Boston, MA: Little, Brown, 1990. 83 pp. Explains how to choose a bike, equipment, accessories, and gives instructions for riding.

Other resources

To secure information about hiking clubs in your area, you may wish to write to the Bureau of Outdoor Recreation, Washington, DC, 20240, or the Department of Conservation in your state capital.

A resource to consult about maps and geography education is the National Council for Geographic Education, Western Illinois University, Macomb, IL.

The following magazines often contain interesting articles on hiking and biking: *Bicycling, Women's Sports and Fitness, Backpacker, Outside, Sport's Afield, Boys' Life,* and *Mountaineer.* For articles on camping and fishing you might want to read: *Boating, Camping Magazine, Country Journal, Field and Stream, Motor Boating, Motor Boating and Sailing, Outdoor Life, Sierra, Sports Afield, Trailer Life,* and *Travel-Holiday.*

ABC's of Compass and Map, The. Presented by John Street. Riverton, WY: Brunton U.S.A., 1989. 1 videocassette, 25 minutes. Provides activities to develop the basics of compass and map skills.

Anatomy of a Trout Stream. John Fabian (Producer). St. Paul, MN: Leisure Time Products, 1984. 1 videocassette, 60 minutes. Hints about learning where trout will be in a stream.

Basic Fly Casting. Doug Swisher. St. Paul, MN: Scientific Anglers/3M, 1987. 1 videocassette, 63 minutes. A short course in fly casting.

Bicycle Repair. Tom Cuthbertson. Charlotte, NC: Do It Yourself Video Corp., 1985. 1 videocassette, 60 minutes. Explains step-by-step roadside bicycle repair.

Bicycle Repair Made Easy. Los Angeles, CA: Increase Video, 1986. 1 videocassette. Explains bicycle maintenance and repair.

Bicycle Safety Camp. Broad Street Productions (Producer). Los Angeles, CA: David Levine & Assoc., Inc. 1 videocassette, 25 minutes. For children ages 6–12, shows cycling safety.

Campfire Sing-Along. F. Olsen. Allen, TX: Lyons Corp., 1990. 1 videocassette, 45 minutes. Barney, the dinosaur, introduces the backyard gang to the fun of camping out.

Geo-Safari. Tucson, AZ: Zephyr Press, 1989. Electronic machine, user's guide, and full-color maps. Requires four D-cell batteries. Students learn basic map skills.

Map and Globe Terms. Beth Kirk and Purves Harley, Jr. Marina del Rey, CA: Tell Me Why Sales Company, 1991. 1 videocassette, 15 minutes. Explains the meanings of map and globe terms.

Map Skills. Beth Kirk and Purves Harley, Jr. Marina del Rey, CA: Tell Me Why Sales Company, 1991. 1 videocassette, 15 minutes. A geography tutorial on map skills.

Ontario 2. Milton Van Der Veen (Producer). Chapel Hills, NC: TVO Video, 1984. 1 videocassette, 30 minutes. Describes the mining, forestry, logging, and fishing of Ontario.

Sleep Out. Carol and Donald Carrick. Boston, MA: Book and Cassette Favorites, 1988. 1 book, 30 pp.; 1 sound cassette, 15 minutes. Tapekit on camping.

Tying Western Trout Flies. Jack Dennis. Jackson Hole, WY: Snake River Books, 1986. 1 videorecording, 120 minutes. How to select animal hair and the tools to use in tying flies.

Types of Maps and Map Projections. Beth Kirk and Purves Harley, Jr. Marina del Rey, CA: Tell Me Why Sales Co., 1991. 1 videocassette, 15 minutes. Discusses types of maps and map projections.

Where in the World? Tucson, AZ: Zephyr Press, 1986. World awareness games with four levels of challenge. Teaches geographic, cultural, and economic facts.

Exploring the watery world

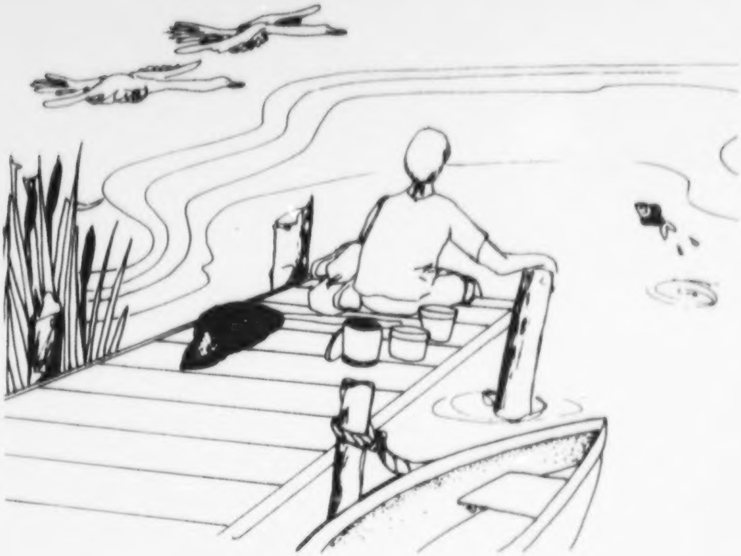
Most kids love water and are fascinated by life in and around it. Exploring the watery world with a single child or with a class of students can be exciting. It also poses some special safety concerns, so if you are making a watery world exploration with a group of students, be sure to have one adult for every five children. Outline very carefully and be sure everyone understands procedures before you begin your outing.

Wherever you live, you can probably visit a pond, lake, or stream. If you live in the country or the mountains, you may be able to plan a hiking, biking, fishing, or camping trip along with your visit to a favorite stream. If you live in a city, you may need to content yourself with a visit to a lake in a park or even a trip to see a large aquarium.

On your explorations, you are sure to see a variety of interesting water plants, fish, insects, and animals that will probably arouse the children's curiosity and lead to further investigations. If you have time, space, and interest, your observations, reading, and research may lead you and your curious kids to want to keep some pets from the pond.

If you are going to collect specimens, it's wise to make some preparations ahead of time—you will certainly need some kind of containers. Since not all water creatures live happily together, it may be a good idea to have several medium-size containers rather than a single large one. Some of your containers may be kept open, while others will need a screen or glass top.

Whatever kind of container you use should have a wide top opening so that it will let in enough oxygen. You can use a gallon jar, a plastic vegetable crisper, a pottery casserole dish, an enamel bucket or dishpan, a plastic dishpan, or an aquarium tank. It is not a good



idea to use metal containers because they may make the water poisonous to fish and other creatures.

Keeping pond specimens

To make preparations to house your pond specimens, first thoroughly clean the containers that you are going to use. In cleaning your containers, be sure not to use soap. Use fresh, hot water and a rubber scraper or a copper pad if it is needed to remove scum from an old tank.

Spread a layer of sand or fine gravel about 2 inches deep over the bottom. Have the sand or gravel higher in the back than in the front so that you can siphon out any dirt that collects. (If you are going to keep your pond creatures long, it is wise to invest in an aquarium and to place an undergravel filter in the bottom, beneath the aquarium sand. This filter can be attached by a plastic tube to an air pump, and helps keep your aquarium water clean. If you are only going to keep your pond specimens for a few hours or days and then return them to the pond, a temporary container should work just fine.)

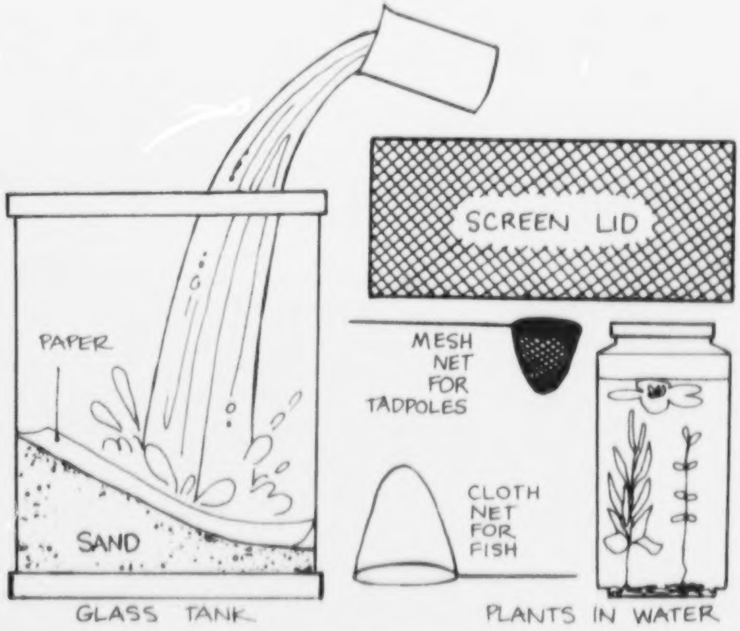
When you pour water into your container, put a piece of clean paper over the sand or gravel before pouring to keep the water from getting cloudy. When you are done pouring, remove the paper. Wait at least 24 hours after pouring the water to allow any chlorine to escape before adding plants or animals.

You may collect a pail of pond water to use in your aquarium. This water may be used right away for plants and animals.

If you are going to keep air-breathing, pond creatures, provide a clean stone with a flat top for them to crawl out of the water and rest upon. You may also want to use a screen, a mosquito net, or glass to cover the top. If you use glass, put a small piece of cork on top of each of the corners of your aquarium to rest the glass on. This will create an air space.

Now, you're ready to house your pond specimens!

When you and your class or your curious child go out to collect snails, fish, or plants for your pond aquarium, take along pails or other containers, a cloth net, a metal strainer, and wear old sneakers that you can wade in. Be sure to always practice water safety.



Collecting snails, fish, and tadpoles

To collect snails, take a kitchen strainer and tape a stick onto it so that you have a longer handle. Poke along the shallow edge of a lake, pond, or stream. Scoop up your find in the strainer and put it in a bucket of pond water to carry home.

To catch fish, you will need a cloth net that you can buy or make. Look for small fish in ponds, along the shallow edges of a lake, or in brooks. (Fish that live in swift rivers or streams usually cannot live in a container unless you have a good system to aerate the water.) Sweep your net down through the water toward your feet while wading. Carry your find home in your bucket of pond water.

To catch tadpoles, use a small-meshed net. In spring and summer you will find tadpoles among plants in shallow water along the shore. Scoop your tadpoles up with the net and carry your find home in your bucket of pond water.

While you are on your exploration, you can also look for some aquatic plants to carry home. When you dig up the aquatic plants, try not to disturb the roots. Floating plants may be taken without roots. Keep the plants wet until you get them home.

Rinse the plants with fresh water before planting them in your aquarium. Let the roots of the plant spread out as you lower it in the water. Use your fingers or a fork to do the planting and then cover the roots with the sand from the bottom of your aquarium.

Even if you decide that you do not want to collect specimens and try to maintain a pond aquarium at home, you can still learn a lot by visiting ponds, lakes, and streams. It is handy to carry a notebook to jot down what you observe, noting the place, date, and time of your discoveries. You way want to bring along materials so the child can sketch some of the fish, birds, insects, animals, or plants and include these sketches in his or her notes.

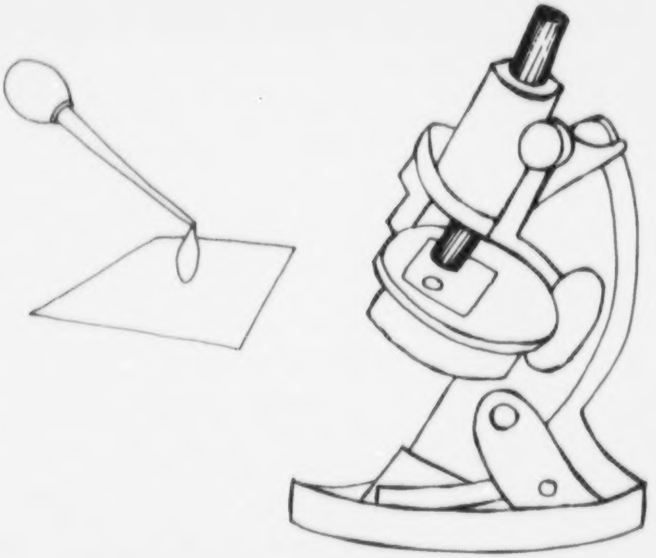
Using a microscope to study water

Taking a water sample and studying a drop of water under a microscope can be a most interesting activity. A bucket, securely tied to a string can be used to drop from a bridge, boat, or bank to collect a sample of the pond or lake water.

Although the drop of water may appear to be clear, under a microscope the child may find it teeming with tiny water plants and animals. Magnification of 20X to 200X is most useful for this purpose.

Encourage your curious child to draw what is observed under the microscope and to add these drawings to his or her field notes as to where and when you collected the water sample.

Another interesting item for a curious kid to collect is a snail shell. The following experiment will discuss just how to do so.



Collecting snail shells

If you visit a fresh water area where it is permitted, collecting snail shells for study can be fascinating. These mollusk shells are made chiefly of calcium-containing minerals. Aquatic mollusks are more commonly found in "hard water" areas.

You might hope to find water snails (pulmonates) that breathe air when they float up to the surface of the water and open their breathing hole to take in air. The great pond snail, ram's horn snail, and bladder snail are three that you might find.

Other snails (prosobranchs) breathe by absorbing oxygen from the water through their gills. You might also find valve, river, and spire snails.

In ponds and streams, you will discover many different types of water plants. It is interesting to note the differences between water plants and land plants. Among the details you and your curious child or class of students will note about underwater plants are: they do not

need thick stems to support them, they have large air spaces inside their leaves to keep them floating in the water, and they take in water and dissolved gases and nutrients over their whole surface. Land plants, however, take in water only through their roots and release it only through their leaves—called transpiration. The following experiment will help your curious child understand this phenomenon.

Displaying transpiration

To show transpiration in action, tie a plastic lunch bag around a shoot on a potted plant. Make a tight seal. After a few hours, check the plastic bag. There will be drops of water inside it.

Another interesting phenomenon that the curious child can observe is a plant making food.

Showing how plants make food

Cut a shoot of Canadian pondweed and put it in a clean pickle jar. The plant will give off oxygen when it makes food in sunlight.

If you put the jar with the pondweed in a sunny spot, you will be able to observe bubbles of oxygen. If you then move the jar of the pondweed out of the sunlight, the bubbles will cease to rise.

A visit to a fish shop or to a large aquarium can be a very interesting trip even if you do not plan to keep fish at home. You will be able to see many different types of fish, plants, and other water life. You can observe egg layers, live bearers, and bubble-nest builders and will probably see tropical fish of every color of the rainbow. In addition, you may see frogs, turtles, snails, salamanders, and newts.

As a result, you may decide to set up a tropical aquarium. Your pet shop probably has simple starter kits for beginners. The basic needs are similar to those discussed in setting up a pond aquarium: a clean tank, an undergravel filter, an air pump, and a heater, plus aquarium gravel and plants.

Your specialty pet shop will be helpful in suggesting fish that are compatible with one another and that are the right size for the tank that you will be using. After you have maintained your aquarium for a while, some shops will even take your too-large fish or baby fish in trade for other fish or aquarium supplies.

Although you will probably not find as many live animal specimens to take home, a visit to the river can be as equally exciting as your trips to ponds, lakes, and small streams. Depending on the season of the year and the part of the country you are in, you might see a barred owl, an egret, a snake, a garfish, crayfish, a turtle, lichens and mosses, warblers, an otter, ferns, or wildflowers. And you will certainly find a lot of interesting rocks on the river bottom, too.

Many of the resource books that follow should be of help in your watery world explorations. You might also want to read the section on water birds in Chapter 5 "Exploring Ethology" and the section on salt water aquariums in Chapter 10 "Exploring the Ocean." Chapter 4 "Exploring Botany" and Chapter 8 "Exploring Geography and Cartography" might also be of interest on the topic.

Resource books

**Animal Homes: Water*. Shirley Greenway. Brookfield, CT: Newington Press, 1991. 24 pp. Discusses aquatic animals in seas, lakes, rivers, and ponds.

Aquarium Book, The. George Ancona. New York, NY: Clarion Books, 1991. 47 pp. Explores four major aquariums through text and photos.

Be an Expert Naturalist. John Stidworthy. New York, NY: Gloucester Press, 1991. 32 pp. Examines various environments including a pond, seashore, and woodland.

Call of the Running Tide, The: A portrait of an island family. Nancy Price Graff. Boston, MA: Little, Brown, 1992. 77 pp. Describes a fishing family on Swan's Island off the coast of Maine.

Discovering Pond Life. Colin S. Milkins. New York, NY: Bookwright Press, 1990. 47 pp. Describes the physical characteristics of plant and animal life of a pond.

Fish. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1990. 48 pp. Discusses various sea animals.

Fishy Shape Story, A. Joanne and David Wylie. Chicago, IL: Childrens Press, 1984. 27 pp. Describes a fishing adventure, as a child introduces fish of different shapes such as triangles, squares, and so forth.

Food from the Sea. Daniel Rogers. New York, NY: Bookwright Press, 1991. 32 pp. Discusses fish, types of fishing, and fish farming.

Glacier National Park. Ruth Radlaver. Chicago, IL: Childrens Press, 1984. 48 pp. Discusses the sheep and glaciers in the park along with information on hiking and camping.

Goldfish: Everything about aquariums, varieties, care, nutrition, diseases, and breeding. Marshall Ostrow. New York, NY: Barron's, 1985. 88 pp. Gives information on how to set up and maintain an aquarium of goldfish.

Hidden Life of the Pond, The. David M. Schwartz. New York, NY: Crown Publishers, 1988. 40 pp. Explores the animals, plants, and insects of a pond through photos and text.

Howell Beginner's Guide to Garden Ponds. Brian Robinson. New York, NY: Howell Book House, 1985. 52 pp. Explains how to set up a garden pond.

Insects in the Pond. Hidetoma Oda. Milwaukee, MN: Raintree Childrens Books, 1986. 32 pp. Explains a pond's ecosystem and shows diving beetles, water scorpions, and dragonflies.

Inside the Aquarium. Wendy Wax. Chicago, IL: Contemporary Books, 1989. 32 pp. Tells a story of how a girl observes the work in a large, metropolitan aquarium.

In the Water—On the water. Dorothy Chlad. Chicago, IL: Childrens Press, 1988. 31 pp. Gives pointers to readers on water safety.

Lake. Lionel Bender. New York, NY: Franklin Watts, 1989. 32 pp. Discusses lake ecology.

Let's Explore a River. Jane R. McCauley. Washington, DC: National Geographic Society, 1988. Explore the plants and animals along a river during a canoe trip as seen by a father and his three children.

Life in the Water. Editors of Time-Life. Alexandria, VA: Time-Life Books, 1989. 87 pp. Discusses such topics as sharks, crabs, fish, frogs, and barnacles in a question/answer format.

Living Pond, The. Nigel Hester. New York, NY: Franklin Watts, 1990. 32 pp. Explores plants and animals in a pond habitat.

Living River, The. Nigel Hester. New York, NY: Franklin Watts, 1991. 32 pp. Shows the network of animals, insects, fish, and plants that cohabit rivers.

My Camera: At the aquarium. Janet Perry Marshall. Boston, MA: Little, Brown, 1989. 32 pp. Sea animals are seen slightly askew, the readers guess, and then there is a clear view of the creature.

My First Visit to the Aquarium. G. Sales and J.M. Parramon. New York, NY: Barron's, 1990. 31 pp. Tells a story of a teacher who takes her class to visit an aquarium and learns about marine animals.

**My Summer Vacation*. Sumiko. New York, NY: Random House, 1990. 30 pp. Describes a little girl's camping trip.

Olympia National Park. Ruth Radlaver. Chicago, IL: Childrens Press, 1988. 48 pp. Describes the physical features, plants, animals, and camping accommodations in Olympia National Park.

Pond & River. Steve Parker. New York, NY: Alfred A. Knopf, 1988. 64 pp. Discusses plants, animals, fish, and waterfowl that might be found in ponds and rivers.

Pond Life. Terry Jennings. Chicago, IL: Childrens Press, 1989. 34 pp. Provides an introduction to pond life, including study questions, activities, and experiments.

Ponds & Streams. John Stidworthy. Mahwah, NJ: Troll Associates, 1990. 31 pp. Discusses the characteristics of various animals that live in or around ponds and streams.

Puddles and Ponds. Rose Wyler. Englewood Cliffs, NJ: Julian Messner, 1990. 32 pp. Contains experiments about plants and animals that live in and around ponds and other small bodies of water.

Riddle King's Camp Riddles, The. Mike Thaler. New York, NY: Random House, 1989. 32 pp. Contains riddles about camping.

River, The. David Bellamy. New York, NY: C.N. Potter (distributed by Crown), 1988. 26 pp. Shows how plants and animals co-exist in a river and what happens during a man-made catastrophe.

Riverkeeper. George Ancona. New York, NY: Macmillan, 1990. 48 pp. Examines the duties of John Cronin, riverkeeper of the Hudson River, through text and photos.

Taking Care of your Fish. Joyce Pope. New York, NY: Franklin Watts, 1987. 32 pp. Offers important facts about aquarium fishes.

Tropical Fish. Pam Jameson. Vero Beach, FL: Rourke Enterprises, 1989. 32 pp. Contains instructions for set up, selection, and care of tropical fish in an aquarium.

Other resources

The following magazines may contain articles of interest on camping and fishing: *Boating, Camping Magazine, Country Journal, Field and Stream, Motor Boating, Motor Boating and Sailing, Outdoor Life, Sierra, Sports Afield, Trailer Life*, and *Travel-Holiday*.

Places that you may wish to write for information include: American Fisheries Society, 5410 Grosvenor Lane, Suite 100, Bethesda, MD 20814–2199; National Wetlands Conservation Project, c/o Nature Conservancy, 1800 North Kent Street, Suite 800, Arlington, VA 22209; and the U.S. Fish and Wildlife Service Publications Unit, 1717 H Street, N.W., Room 148, Washington, DC 20240.

Anatomy of a Trout Stream. John Fabian (Producer). St. Paul, MN: Leisure Time Products, 1984. 1 videocassette, 60 minutes. Hints about learning where trout will be in a stream.

Babies of the Pond. Bill Grunkmeyer (Producer). Sheridan, WY: Grunko Films, 1988. 1 videocassette, 45 minutes. Offers hints on pond ecology.

Box Turtle at Long Pond. William T. George. Norwalk, CT: Soundprints, 1989. 1 book, 26 pp.; 1 sound cassette, 10 minutes. Involves the busy day of a box turtle.

Trip to the Aquarium, A. East Aurora, NY: Fisher-Price, 1987. 1 videocassette, 30 minutes. Shows an aquarium visit.

10

Exploring the ocean

It's hard to imagine living on our planet and not being interested in oceans. Three-quarters of the earth's surface is covered by water. If you and your classroom of students or your curious child live near an ocean, trips to the shore are probably a common part of your life. For others who are landlocked, only rare vacations take the family to beaches and coasts, but the interest in oceans may still be high from reading, television programs, and videos.

One of the fascinating things about exploring oceans, is that there is still so much to learn about them and the life within them. We've sent astronauts to walk on the moon, but no one has stepped on the deepest spot in the ocean floor—35,000 feet below the surface.

With new scientific advances in technology and equipment, more and more ocean exploration is taking place. Scientists study currents, tides, waves, and the fish, animals, and plants that live in the oceans and seas.

Scientific ocean exploration often makes the news. Perhaps a sunken treasure is located or an underwater lab sets records for the length of time humans have spent beneath the water. At other times we read or hear reports that contain disturbing information about the pollution that is taking place in our ocean waters. There have been gigantic oil spills that foul the waters, spoil resort beaches, and destroy fish and marine animals. Sometimes factories and cities spill waste into the waters.

At yet other times, some sea creature, such as Humphrey the Wrong-Way Whale, captures the interest of the public and is featured in headlines and on television programs. Any such event may provoke interest in curious kids and provide a natural springboard to studying more about some aspect of the ocean that is of immediate interest.

One of the first things a curious child may ask about ocean water is how is it different from fresh water. What's in ocean water? The following experiment will help examine the differences.

Examining the different substances in salt water

Put a small amount of seawater into an enamel saucepan on a burner. Carefully boil the water away, turn the flame off, and allow the pan to cool.

Wet an ordinary steel sewing needle with tap water and rub the needle in the salt that is left at the bottom of the pan. Using a pot holder and tongs, carefully hold the salt-covered needle in the blue flame of a gas burner. The heated salt will give off colors depending upon the different minerals that they contain. Sodium, for example, gives off a yellow color (two-thirds of the ocean salt is sodium chloride). Potassium will give off a purple color, calcium will be orange, and copper will give off a green color.

Through this simple experiment of seeing colors, you will learn something about the different substances that are in salt water.

Another simple experiment will show how objects float differently in salty water than in fresh water.

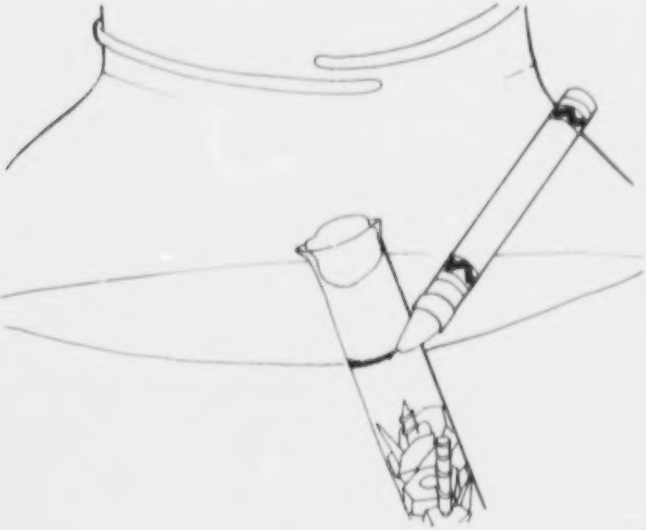
Showing how objects float

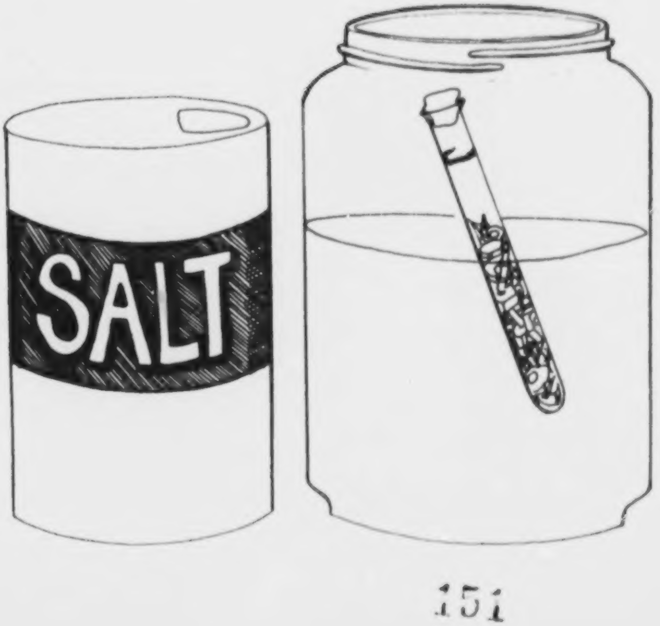
Take a wide-mouthed jar and fill it with fresh water. Take a test tube and put some weights in it such as small nuts and bolts. Push some plastic clay into the test tube to hold the weights in place. Cork the test tube tightly and float it in the water. (Add enough weight so that about half of the test tube is below the water.) Mark the water level on the test tube with a marking crayon.

Now remove your test tube and add salt to the water. Stir. Replace the test tube in the salty water. Mark the water level on the test tube now. The test tube floats higher in the salty water than it did in the fresh water.

Salty water is heavier and denser than fresh water, and a dense liquid supports a floating object more easily than a less dense liquid.

Knowing that salt water is denser than fresh water and is filled with many different substances may cause a class of students or a curious child to ask if you can turn salt water into fresh drinking water—and, of course, you can! The following experiment will show you how.





Turning salt water into fresh water

Get two, disposable, aluminum baking pans. Paint the inside of the smaller pan black. Punch a hole in a bottom corner of the larger pan. Place the smaller black pan, filled with salt water, inside the larger empty aluminum pan that has a hole poked in a bottom corner.

At each end of the aluminum pans, bend a coat hanger to form a triangular shape. Use clear plastic wrap to form a tent supported by the coat hangers, covering the aluminum pans.

Place your tented pans on a block of wood in the bright sun. The block of wood should be high enough so that you can place a glass to collect water right under the hole you punched in the large aluminum pan.

The black pan will absorb the rays of sun and become warm. As the pan warms the water, the water evaporates and becomes water vapor. The vapor condenses back into water, drips down the plastic into the larger aluminum pan and out through the hole in the pan into a glass.

The water in the glass will not be salty.

The curious kid or the group in the class who have questions about how huge airplanes can fly in the sky will probably also have questions about how huge ocean liners, filled with passengers and cargo, can stay afloat in the water. A few simple materials in your kitchen sink can help explain this mystery.

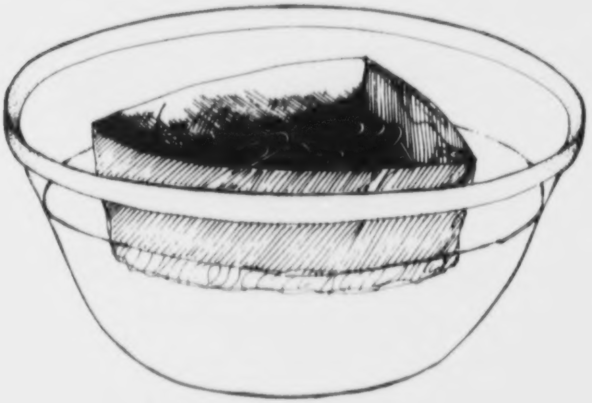
Determining an object's floatability

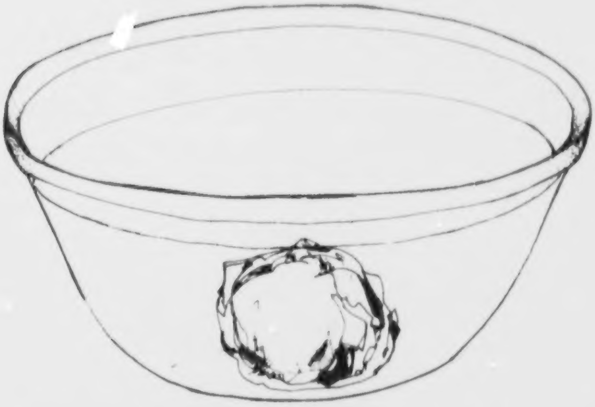
This experiment will help your curious child understand that a floating object has enough volume (or size) to displace its own weight in water.

Fill a large mixing bowl ½ full of water. Use aluminum foil to shape a small boat about 4 inches long and 2 inches wide. Put the boat in the water and watch it float. One by one, add 12 paper clips to the boat for cargo and notice that the boat still floats.

Now squish the aluminum boat with the paper clips in it into a lump. Drop the lump into the water. Even though the foil and clips still weigh exactly the same as before, the crumpled boat sinks because its size and shape have changed.

The next best thing to visiting the shore or a large marine aquarium to observe marine animals is to set up a salt water aquarium in your home. This takes considerable time and effort and should not be undertaken lightly. Reference books will be helpful, but someone





who already maintains such an aquarium or someone from a local pet shop/fish supply shop who is knowledgeable and friendly will be of utmost value.

Setting up a salt water aquarium

Setting up and maintaining a salt water aquarium is a challenge, but when successful, the results are exciting.

You need a 10-gallon, all-glass aquarium with a cover, an undergravel filter, 10 pounds of aquarium gravel, and an air pump. First wash thoroughly with fresh water (no soap) you tank, filter, and gravel. Place the filter in the bottom of the tank, attach a flexible plastic air tube to the filter and to the air pump and cover the filter with 3 inches of gravel.

You can collect natural sea water to put in your tank if you live near the ocean, choosing a clean place to collect it. Gather the water in clean plastic bags and filter it to remove any dirt. You can make artificial seawater by buying 3 pounds of marine salt and mixing it with 10 gallons of water.

Once the aquarium is set up, every few days add fresh water (not salt water) to replace the water that has evaporated. Put in an aquarium thermometer so that you can maintain a constant temperature. Also use a hydrometer so that you can keep the salinity constant. Place your aquarium where it is not in direct sunlight or near a heater or drafts. Cover the aquarium to keep out dirt. Let the water sit for three weeks before adding any plants or marine animals.

Once your aquarium is established, you can begin adding your plants and animals.

Maintaining plants and animals in a salt water aquarium

Selecting and maintaining plants and animals in your salt water aquarium take careful thought. Discuss this with your local aquarium/pet shop dealer. Certain plants and animals can be purchased that will not harm one another and that can adjust to minor temperature fluctuations.

If you live near the ocean and collecting specimens is not prohibited in your area, you might be able to collect your own creatures by using nets and containers and searching tide pools.

Once you have marine animals, float them in a plastic bag containing their original water in your tank, allowing time for water temperatures to adjust, before letting them into the tank. Watch new animals closely. If they appear to be sick or if they die, remove them immediately.

Most sea animals can be fed live brine shrimp and very small bits of lean meat. Feed your fish a small amount once a day, removing uneaten scraps of food from the water.

There are numerous books available about specific sea creatures, tides, currents, and other topics that relate to the ocean. Once you and your class or your curious child begin your study of the ocean, one topic may very well lead to another. Other sections of this book, especially Chapter 9 "Exploring the Watery World," might prove helpful.

Resource books

Album of Whales. Tom McGowan. New York, NY: Checkerboard Press, 1987. 61 pp. Provides an introduction to various types of whales, dolphins, and porpoises.

Animals of the Seashore. Hidetoma Oda. Milwaukee, MN: Raintree Childrens Books, 1986. 32 pp. Describes the life cycle of crabs, sea anemones, and sea snails.

Arctic, The. Pat Hargreaves (Editor). Morristown, NJ: Silver Burdett Press, 1987. 66 pp. Offers an introduction to the Arctic Ocean.

Atlantic, The. Pat Hargreaves (Editor). Morristown, NJ: Silver Burdett Press, 1987. 66 pp. Gives an introduction to the Atlantic Ocean.

Atlantic Gray Whale, The. Jan Mell. Mankato, MN: Crestwood House, 1989. 48 pp. Describes ancient and modern whaling.

Atlantic Ocean, The. Susan Heinrichs. Chicago, IL: Childrens Press, 1986. 47 pp. Describes features of the Atlantic Ocean and discusses its inhabitants.

**Baby Whale*. Lynn Wilson. New York, NY: Platt & Munk, 1991. 30 pp. Tells about a baby whale.

Blue Whales. Sarah Palmer. Vero Beach, FL: Rourke Enterprises, 1988. 23 pp. Describes the blue whale.

Bottlenose Dolphin, The. William R. Sanford and Carl R. Green, Mankato, MN: Crestwood House, 1987. 47 pp. Discusses the physical characteristics and the life cycle of bottlenose dolphins.

Can the Whales Be Saved?: Questions about the natural world and the threats to its survival answered by the natural history museum. Philip Whitfield. New York, NY: Viking Kestrel, 1989. 96 pp. Discusses the balance of nature in a question/answer format.

Continental Shelf, The: An underwater frontier. Alice Gilbreath. New York, NY: Dillon Press, 1986. 103 pp. Describes the shelves under the world's oceans at the shoreline.

Coral Reefs. Sylvia A. Johnson. Minneapolis, MN: Lerner Publications Co., 1984. 55 pp. Examines different kinds of coral reefs through text and photos.

Corals: The sea's great builders. Cousteau Society. New York, NY: Books for Young Readers, 1992. 28 pp. Describes how corals grow, eat, and nourish other animals.

**Crabs*. Donna Bailey and Christine Butterworth. Austin, TX: Steck-Vaughn Library, 1991. 32 pp. Describes the different kinds of crabs, and uses of claws and legs to catch food, walk, and swim.

Danger—Icebergs! Roma Gans. New York, NY: Thomas Y. Crowell, 1987. 31 pp. Explains how icebergs are formed and how they move in oceans.

Discovering Crabs and Lobsters. Jill Bailey. New York, NY: Bookwright Press, 1987. 46 pp. Describes the habitat, food, and behaviors of crabs and lobsters.

Discovering Jellyfish. Miranda MacQuitty. New York, NY: Bookwright Press, 1989. 47 pp. Discusses jellyfish, sea anemones, coral, and hydras.

Discovering Otters. Martin Banks. New York, NY: Bookwright Press, 1988. 46 pp. Provides an introduction to sea and freshwater otters.

Dolphin Adventure: A true story. Wayne Grover. New York, NY: Greenwillow Books, 1990. 47 pp. Tells about a diver who gains the trust of a dolphin.

**Dolphins.* Sarah Palmer. Vero Beach, FL: Rourke Enterprises, 1989. 24 pp. Discusses dolphins, their habits, and behaviors in simple understandable terms.

Easy Answers to First Science Questions about Oceans. Q. L. Pearce. New York, NY: Smithmark Publishers, 1991. 31 pp. Offers information on marine science.

Fin Whales. Sarah Palmer. Vero Beach, FL: Rourke Enterprises, 1988. 23 pp. Describes the most common fin whales.

Follow the Water from Brook to Ocean. Arthur Doros. New York, NY: HarperCollins, 1991. 32 pp. Explains how water travels from brooks to reach the ocean.

Footsteps in the Ocean: Careers in diving. Denise V. Lang. New York, NY: Dutton, 1987. 143 pp. Discusses sport and commercial diving and scientific and military research.

Golden Book of Sharks and Whales, The. Kathleen N. Daly. Racine, WI: Western Publishing Co., 1989. 45 pp. Discusses the habitat and behavior of sharks and whales.

Gray Whales. Sarah Palmer. Vero Beach, FL: Rourke Enterprises, 1988. 23 pp. Gives a discussion of gray whales.

Great Barrier Reef, The: A treasure in the sea. Alice Gilbreath. New York, NY: Dillon Press, 1986. 103 pp. Describes the construction of the barrier reef and the life among it.

Great Whales, The Gentle Giants. Patricia Lauber. New York, NY: Henry Holt, 1991. 64 pp. Describes the characteristics and behaviors of different kinds of whales and the threats they face.

Hermit Crabs. Sylvia A. Johnson. Minneapolis, MN: Lerner Publications Co., 1989. 47 pp. Introduces the reader to the hermit crab.

Hidden Treasures of the Sea. Washington, DC: National Geographic Society, 1988. 104 pp. Provides an introduction to nautical archeology.

Homes in the Sea: From the shore to the deep. Jean H. Sibbald. New York, NY: Dillon Press, 1986. 95 pp. Provides an introduction to sea animals.

How to Be an Ocean Scientist in Your Own Home. Seymour Simon. New York, NY: J. B. Lippincott, 1988. 136 pp. Contains a collection of experiments to reveal the different characteristics of oceans.

Humpback Whale. Michael Bright. New York, NY: Gloucester Press, 1990. 32 pp. Discusses the characteristics, feeding habits, and migration routes of whales.

Humpback Whales. Dorothy Hinshaw Patent. New York, NY: Holiday House, 1989. 32 pp. Discusses the physical characteristics, habitat, and behavior of humpback whales.

Humpback Whales. Sarah Palmer. Vero Beach, FL: Rourke Enterprises, 1988. 23 pp. Discusses humpback whales.

Humphrey, The Wrong Way Whale. Kathryn A. Golner and Carole Garbung Vogel. New York, NY: Dillon Press, 1987. 127 pp. Tells the story of a whale off the coast of California.

Incredible Facts about the Ocean. W. Wright Robinson. New York, NY: Dillon Press, 1986. 3 vols. Provides facts about oceans in a question and answer format.

Indian Ocean, The. Pat Hargreaves (Editor). Morristown, NJ: Silver Burdett Press, 1987. 65 pp. Introduces the reader to the Indian Ocean.

Indian Ocean, The. Susan Heinrichs. Chicago, IL: Childrens Press, 1986. 45 pp. Discusses ocean features such as plants, animals, and volcanic action.

Jacques Cousteau: Man of the oceans. Carol Greene. Chicago, IL: Childrens Press, 1990. 45 pp. Provides a simple biography of Jacques Cousteau.

Jane Goodall's Animal World: Sea otters. Ruth Ashby. New York, NY: Atheneum, 1990. 30 pp. Offers an introduction to sea otters.

Jellyfish to Insects: Projects with science. William Hemsley. New York, NY: Gloucester Press, 1991. 32 pp. Contains experiments and projects for investigating the life cycle and behavior of the main groups of invertebrates.

Killer Whales. Sarah Palmer. Vero Beach, FL: Rourke Enterprises, 1988. 24 pp. Discusses the physical characteristics, habits, and environment of killer whales.

Killer Whale, The. Lynn M. Stone. Mankato, MN: Crestwood House, 1987. 47 pp. Describes the physical characteristics, habitat, and behavior of killer whales.

Life Cycle of a Crab, The. Jill Bailey. New York, NY: Bookwright Press, 1990. 32 pp. Describes the physical characteristics, habitat, food, and reproduction of crabs.

**Life in the Oceans.* Lucy Baker. New York, NY: Franklin Watts, 1990. 31 pp. Examines plants, animals, and minerals in the ocean.

Life in the Oceans. Norbert Wu. Boston, MA: Little, Brown, 1991. 96 pp. Offers an introduction to life in the ocean from microscopic plants to sharks.

**Life in the Sea.* Jennifer Coldrey. New York, NY: Bookwright Press, 1991. 32 pp. Provides an introduction to fish, reptiles, birds, mammals, and plants that live in or near oceans.

Living Fossils. Joyce Pope. Austin, TX: Steck-Vaughn Library, 1992. 47 pp. Discusses species that have survived over millions of years such as the shark, crocodile, and horseshoe crab.

Living Ocean, The. Robert A. Mattson. Hillside, NJ: Enslow Pub., 1991. 64 pp. Describes the different kinds of organisms found in oceans.

Make a Splash! Thompson Yardley. Brookfield, CN: Millbrook Press, 1992. 40 pp. Explores oceans and threats to them.

Migration in the Sea. Liz Oram and R. Robin Baker. Austin, TX: Steck-Vaughn Library, 1992. 47 pp. Describes the migration patterns of turtles, whales, salmon, anemones, barnacles, crabs, and sea lions.

Monster Seaweeds: The story of the giant kelp. Mary Daegling. New York, NY: Dillon Press, 1986. 119 pp. Discusses the kelp that are home for countless sea creatures.

Monsters of the Deep. Norman Barrett. New York, NY: Franklin Watts, 1991. 32 pp. Offers a look at sharks, jellyfish, and octopus.

Narwhales. Sarah Palmer. Vero Beach, FL: Rourke Enterprises, 1988. 23 pp. Discusses this toothed whale.

Near the Sea: A portfolio of paintings. Jim Arnosky. New York, NY: Lothrop, Lee & Shepard Books, 1990. 28 pp. Contains paintings of beach, rock, water, gulls, and fish.

Night of the Sea Turtle, The. Lynn M. Stone. Vero Beach, FL: Rourke Enterprises, 1991. 48 pp. Explains the life and habits of loggerhead turtles.

**Ocean.* Ron Hiroschi. New York, NY: Bantam Books. 1991. 32 pp. Depicts ocean animals as they describe their behavior and characteristics and asks the reader to guess what they are.

•*Ocean Alphabet Book, The*. Jerry Pallotta. Watertown, MA: Charlesbridge, 1986. 29 pp. Shows fish and other creatures, from A to Z.

Ocean Animals. Michael Chinery. New York, NY: Random House, 1992. 40 pp. Provides an introduction to animals of the ocean.

Ocean Book, The: Aquarium and seaside activities and ideas for all ages. Center for Environmental Education. New York, NY: John Wiley & Sons, 1989 113 pp. Contains ideas for many activities.

Ocean Floor, The. Keith Lye. New York, NY: Bookwright Press, 1991. 32 pp. Discusses the origin of oceans and the characteristics of the ocean floor.

Ocean Life. David Cook. New York, NY: Crown Publishers, 1985. 30 pp. Describes the dangers faced by the animals that live in the sea.

Ocean Life. Les Holliday. New York, NY: Crescent Books (distributed by Outlet Book Co.), 1991. 62 pp. Describes the variety of animals that live in oceans.

Ocean, The. Anne W. Phillips. Mankato, MN: Crestwood House, 1990. 48 pp. Discusses oceans and pollution.

Oceans, The. Martyn Bramwell. New York, NY: Franklin Watts, 1987. 32 pp. Discusses the physical features and the marine life of the world's oceans.

Oceans. Seymour Simon. New York, NY: Morrow Junior Books, 1990. 32 pp. Oceans are explored through text and photos.

Oceans. Philip Whitfield. New York, NY: Viking Penguin, 1991. 72 pp. Offers information on oceanography.

•*Ocean Parade: A counting book*. Patricia MacCarthy. New York, NY: Dial Books for Young Readers, 1990. 26 pp. Contains a variety of colorful fish that introduce numbers through 20.

Ocean World. Tony Rice. Brookfield, CT: Millbrook Press, 1991. 64 pp. Surveys oceans and ocean life.

Octopus, The. Carl R. Green and William R. Sanford. Mankato, MN: Crestwood House, 1988. 47 pp. Discusses the physical characteristics and behavior of an octopus.

•*Octopus Is Amazing, An*. Patricia Lauber. New York, NY: Thomas Y. Crowell, 1990. 32 pp. Provides an introduction to the octopus.

Pacific, The. Pat Hargreaves (Editor). Morristown, NJ: Silver Burdett Press, 1987. 67 pp. Introduces the reader to ocean plants and animals and island life.

Pacific Ocean, The. Luciani Bottoni, Valeria Lucini, and Renato Massa. Milwaukee, MN: Raintree Childrens Books, 1989. 128 pp. Discusses the plant and animal life of the Pacific Ocean.

Pacific Ocean, The. Susan Heinrichs. Chicago, IL: Childrens Press, 1986. 45 pp. Gives basic information about the Pacific Ocean and the ocean floor.

Plight of the Whales, The. J. J. McCoy. New York, NY: Franklin Watts, 1989. 144 pp. Discusses how whales have become endangered.

Protecting the Oceans. John Baines. Austin, TX: Steck-Vaughn Library, 1991. 48 pp. Discusses protecting oceans from pollution.

Reef Comes to Life, A: Creating an undersea exhibit. Nat Segaloff and Paul Erickson. New York, NY: Franklin Watts, 1991. 40 pp. Discusses constructing a coral reef environment for a museum exhibit.

River in the Ocean: The story of the gulf stream. Alice Gilbreath. New York, NY: Dillon Press, 1986. 95 pp. Discusses the warm river flowing in the Atlantic Ocean.

Sea, The. Brian Williams. New York, NY: Warwick Press, 1991. 48 pp. Provides an introduction to the wealth of the sea.

Sea Creatures on the Move. Jean H. Bibbald. New York, NY: Dillon Press, 1990. 95 pp. Offers a collection of ocean poems.

Sea is calling me, The: Poems. Selected by Lee Bennett Hopkins. San Diego, CA: Harcourt Brace Jovanovich, 1986. 32 pp. Offers a collection of ocean poems.

Seals. Eric S. Grace. Boston, MA: Little, Brown, 1991. 62 pp. Describes the physical characteristics, habits, and habitat of seals.

Seals and Sea Lions. Vassili Papastavrou. New York, NY: Bookwright Press, 1992. 32 pp. Describes different species of pinnipeds.

Seals, Sea Lions and Walruses. Victoria Sherrow. New York, NY: Franklin Watts, 1991. 64 pp. Describes the habits and habitats of seals, sea lions, and walruses.

Sea Mammals: The warm-blooded ocean explorers. Jean H. Sibbald. New York, NY: Dillon Press, 1988. 95 pp. Contains information on four groups of sea mammals.

Sea Otter Rescue: The aftermath of an oil spill. Roland Smith. New York, NY: Dutton, 1990. 64 pp. Describes rescue operations after the 1989 Valdez, Alaska oil spill.

Sea Otters. Sarah Palmer. Vero Beach, FL: Rourke Enterprises, 1989. 24 pp. Offers an introduction to sea otters.

Seas and Oceans. David Lambert. Morristown, NJ: Silver Burdett Press, 1988. 48 pp. Provides a look at the world's oceans.

Seas and Oceans. Clint Twist. New York, NY: Dillon Press, 1991. 45 pp. Discusses diverse ocean life.

Seawater: A delicate balance. A. Lee Meyerson. Hillside, NJ: Enslow Pub., 1988. 64 pp. Discusses the saltiness of oceans.

Sea World Book of Whales, The. Eve Bunting. San Diego, CA: Harcourt Brace Jovanovich, 1987. 96 pp. Gives the physical characteristics and habits of various species.

Sharks. Gilda Berger. New York, NY: Doubleday, 1987. 41 pp. Describes 20 major types of sharks.

Sharks. Gail Gibbons. New York, NY: Holiday House, 1992. 32 pp. Discusses different kinds of sharks and their behavior.

Sharks and Other creatures of the Deep. Philip Steele. New York, NY: Dorling Kindersley, 1991. 64 pp. Describes a number of strange and intimidating creatures of the sea.

Sharks: The super fish. Helen Roney Sattler. New York, NY: Lothrop, Lee & Shepard Books, 1986. 96 pp. Discusses shark behaviors and gives tips for swimmers.

Signs of the Apes, Songs of the Whales: Adventure in human-animal communication. George and Linda Harrar. New York, NY: Simon & Schuster, 1989. 48 pp. Describes experiments in which apes and dolphins have been taught aspects of human language.

Six Bridges of Humphrey the Whale, The. Toni Knapp. Colorado Springs, CO: Rockrimmon Press, 1989. 44 pp. Tells how a young humpback whale swims into the San Francisco Bay and winds up in the Sacramento River Delta.

Something's Fishy! Jokes about sea creatures. Rick and Ann Walton. Minneapolis, MN: Lerner Publications Co., 1987. 32 pp. Contains jokes and riddles about the sea.

Story of Three Whales, The. Giles Whittell. Milwaukee, WI: Gareth Stevens Pub., 1989. 28 pp. Describes how an international team tries to save three whales trapped in ice off the coast of Alaska.

Strange Eating Habits of Sea Creatures. Jean H. Sibbold. New York, NY: Dillon Press, 1985. 111 pp. Describes what and how sea creatures eat.

Stranger than Fiction: Sea monsters. Melvin Berger. New York, NY: Avon Books, 1991. 86 pp. Discusses the killer whale, electric eel, and giant squid.

That's for Shore: Riddles from the beach. June Swanson. Minneapolis, MN: Lerner Publishing Co., 1991. 32 pp. Contains riddles about the beach.

Those Amazing Eels. Cheryl M. Halton. New York, NY: Dillon Press, 1990. 94 pp. Discusses the physiology, habits, and uses of eels.

Threatened Oceans. Jenny Tesar. New York, NY: Facts on File, 1991. 112 pp. Explains how fishing, dumping, oil spills, and humans endanger a marine environment.

Tidal Waves and Other Ocean Wonders. Querida Lee Pearce. Englewood Cliffs, NJ: Julian Messner, 1989. 64 pp. Describes the biological and geological wonders found in the ocean depths.

Tidepools. Diana Barnhart and Vicki Leon. San Luis Obispo, CA: Blake Publishing, 1989. 39 pp. Discusses tide pool ecology.

* *Twelve Days of Summer, The*. Elizabeth Lee O'Donnell. New York, NY: Morrow Junior Books, 1991. 30 pp. Tells a counting verse in which a girl sees things at the beach such as one purple sea anemone.

Undersea Archaeology. Christopher Lampton. New York, NY: Franklin Watts, 1988. 96 pp. Describes the use of technology to retrieve artifacts from the ocean floor.

Undersea Technology. Mark Lambert. New York, NY: Bookwright Press, 1990. 47 pp. Examines submarines, mining, oil production, and underwater exploration.

Under the Sea. Brian Williams. New York, NY: Random House, 1989. 24 pp. Offers an illustrated introduction to the sea.

* *Under the Sea*. Jenny Wood. New York, NY: Macmillan, 1991. 29 pp. Reveals the secrets of sharks, whales, and a coral reef during a submarine voyage.

Underwater Life: The oceans. Dean Morris. Milwaukee, MN: Raintree Childrens Books, 1988. 47 pp. Discusses plants and animals of the deep sea.

* *Walk by the Seashore, A*. Caroline Arnold. Morristown, NJ: Silver Burdett Press, 1990. 32 pp. Observes sand, waves, plants, and animals at the shore through a child's eye.

Watching Whales. John F. Waters. New York, NY: Cobblehill Books/Dutton, 1991. 42 pp. Tells about the natural life of whales.

Waves, Tides, and Currents. Daniel Rogers. New York, NY: Bookwright Press, 1991. 32 pp. Tells how waves, tides, and currents are created and the effect on climate and shorelines.

Whale. Jill Bailey. New York, NY: Gallery Books, 1991. 47 pp. Walter Coleman takes six tourists on a boat to a lagoon to see the birth of gray whales.

Whales. Gilda Berger. New York, NY: Doubleday, 1987. 41 pp. Describes 20 species of whales.

Whales. Gail Gibbons. New York, NY: Holiday House, 1991. 30 pp. Introduces the different kinds of whales.

Whales. Anthony R. Martin. New York, NY: Crescent Books (distributed by Outlet Book Co.), 1990. 64 pp. Provides an introduction to whales.

Whales. Louise Martin. Vero Beach, FL: Rourke Enterprises, 1988. 24 pp. Describes 12 species of whales and efforts of the World Wildlife Fund.

Whales. Malcolm Penny. New York, NY: Bookwright, 1990. 32 pp. Introduces different types of whales.

Whales and Dolphins. Vassili Papastavrou. New York, NY: Bookwright Press, 1991. 32 pp. Tells about different kinds of whales.

Whales: And other marine mammals. George S. Fichter. Racine, WI: Golden Press, 1990. 160 pp. Discusses whales, dolphins, porpoises, manatees, dugongs, sea lions, walruses, seals, otters, and polar bears.

Whales of the World. June Behrens. Chicago, IL: Childrens Press, 1987. 44 pp. Describes such creatures as the right whale, bottlenose dolphin, and humpback whale.

Whales, The Nomads of the Sea. Helen Roney Sattler. New York, NY: Lothrop, Lee & Shepard Books, 1987. 126 pp. Describes the physical characteristics and habits of whales and dolphins.

Whales: Whale magic for kids. Tom Wolpert. Milwaukee, WI: Gareth Stevens Pub., 1990. 48 pp. Discusses different kinds of whales.

What's Inside? Shells. Angela Royston. New York, NY: Dorling Kindersley (distributed by Houghton Mifflin), 1991. 17 pp. Offers a first guide to the wonders of life inside shells.

What is a Fish? Barbara R. Stratton. New York, NY: Franklin Watts, 1991. 33 pp. Discusses the common characteristics of fish.

Wonderful World of Seals and Whales, The. Sandra Lee Crow. Washington, DC: National Geographic Society, 1984. 30 pp. Explores seals and whales through text and photos.

World's Oceans, The. Cass R. Sandak. New York, NY: Franklin Watts, 1987. 32 pp. Explains how inventions have extended the scope of ocean exploration.

World of a Jellyfish, The. David Shale and Jennifer Coldrey. Milwaukee, WI: Gareth Stevens Pub., 1987. 32 pp. Discusses the characteristics, habits, and environment of jellyfish.

World of Fishes, The. Hiroshi Takeuchi. Milwaukee, WI: Raintree Publishers, 1986. 32 pp. Discusses the behavior patterns of unusual ocean fish in the deep sea or near coral reefs.

Other resources

A bimonthly magazine of interest might be *Dolphin Log*, Los Angeles, CA, published by the Cousteau Society, Inc.

Big A, The: Telling a story in art. Lincoln, NE: Great Plains National Instructional Television Library, 1987. 1 videocassette, 15 minutes. Shows a field trip to Sea Monster House to discuss the stories and designs in Northwest Coastal Indian arts.

Gift of the Whales. Jan C. Nickman (Producer). Seattle, WA: Miramar Images, 1989. 1 videocassette, 30 minutes. Tells the story of a young boy and his relationship with whales near his village.

Humphrey the Lost Whale: A true story. Wendy Tokuda and Richard Hall. Lincoln, NE: The Library, 1989. 1 videocassette, 30 minutes. Explains how a migrating humpback whale ended up 64 miles inland.

Night-Hunting Lobster, The. Bill Martin, Jr., with John Archambault. Chicago, IL: Encyclopedia Britannica Educational Corp., 1985. 1 book, 14 pp. 1 sound cassette, 10 minutes. A read-along tape kit.

Singing Whales, The. Bill Martin Jr., with John Archambault. Chicago, IL: Encyclopedia Britannica Educational Corp., 1985. 1 book, 14 pp., 1 sound cassette, 10 minutes. Contains a fun-filled tape kit with music and watercolors.

11

Exploring science through your senses

Although scientists often use very sophisticated equipment, it is also true that we take in scientific information through our senses. Exploring science through the senses comes about very naturally because you and your curious child or classroom students are experiencing sensations all the time. We respond to stimuli that are separate from us, and we are constantly using our specialized sense organs: eyes, ears, tongue, nose, and skin.

All of our sense organs have one thing in common—nerve cells. These cells, called receptors, respond to stimuli and carry messages to the brain. For example, eyes are sensitive to light; sound is usually sensed by ears, although some vibrations are sensed by the skin; your nose and mouth are sensitive to chemicals; and the skin responds to temperature, pressure, pain, and helps you to recognize many of the things that you touch. Finally, past experience helps you decide how to respond to the stimuli and sensations that you receive.

Often we take this sensory information for granted, but now and then, something will happen that causes a curious child to stop and think about it. For example, some friend, relative, or classmate may wear glasses or contact lenses, while others may simply put on sunglasses when they go out to drive, ski, or go to the beach. The child may raise questions about these various lenses, why they are worn, and what they do.

Similarly, a friend, relative, or classmate might have a hearing loss and wear a hearing aid. The child might have questions about how this aid works and what it does. The child might comment on the smoothness of a piece of silk or the fender of a new car, or may make an accurate guess at what's cooking for dinner by the smells that are arising in the kitchen. All of these are opportunities for exploring the senses. The following experiment can show how smell affects his or her sense of taste.

Showing how smell affects taste

To show how the sense of taste and smell are interrelated, blindfold a child and have him or her hold the nostrils closed by pinching them between finger and thumb

Then put a small piece of food on the child's tongue and have him or her taste it without chewing and guess what it is.

If you use small pieces of apple, pear, raw potatoes, and onion, the child will probably make some mistakes in the guesses. It is the odors that make these foods taste different.

To demonstrate the sense of touch for your curious child, simply conduct the following experiment.

Demonstrating the sense of touch

There is a simple guessing game you can play with a child to demonstrate his or her sense of touch. Get an ordinary paper bag and put about 20 different items into it. (None of these items should be sharp or pointed—they might cause injury.)

Include many shapes, sizes, and weights. For example, you might include: a plastic spoon, a paper clip, a thimble, a lemon, a pencil, a marble, a clothespin, and a hard-boiled egg.

Have the child reach in the bag without looking inside. Give the child a couple of minutes to feel. Then put the bag aside and have the child name as many items as he or she was able to identify. Older children may write the items in a list. Younger children can simply tell you.

Remove all the identified items and let the child have one more try at the unidentified items. How many of the 20 items could be identified simply by the sense of touch?

Although our senses can help us in identifying objects and making sense of our world, these same senses can sometimes trick us. Our perceptions come from stimuli of the physical world, sensations, and our experience in interpreting data. Although we believe our perceptions to be accurate, we can be deceived. This is when some interesting questions arise.

Confusing your sense of touch

One simple experiment that shows you can be deceived by the sense of touch can be carried out by taking a hairpin or paper clip and spreading apart the two legs into a V-shape.

Touch various parts of the body (e.g., back, hand, leg) with both tips of the V. Vary the distance between the two points that are touching. It may help to close your eyes while you are carrying out this experiment.

On some parts of the body, you will feel two distinct spots where the points of the V are touching. In other parts of the body, although two points are touching, you will feel only one.

Another simple experiment involving our sense of touch uses temperature to trick us.

Determining an object's temperature

Using three pans of water, fill one pan with water at room temperature, a second with ice water and a third with comfortably hot tap water.

Have the child put one hand in the ice water and another in the hot water for 30 seconds. Then have the child put both hands in the water that is room temperature. Ask if the room temperature water is hot or cold.

The water at room temperature will feel warm to the hand that had been in ice water and cool to the hand that had been in hot water.

Exploring the sense of hearing can also be interesting. If the child likes storytelling or dramatics, sound effects will be a natural entry into exploring sounds.

Creating sound effects

First choose a suitable story for recording into a tape recorder. It should be one that has a fair number of possible sound effects (e.g., wind, rain, thunder, fire, foghorn, slamming or creaking doors, gun shot, galloping hoof beats, splashing water).

The story can be original or an old favorite such as *The Three Billy Goats Gruff*, who tramp across a bridge.

Try various ways of making the sound effects. (e.g., breathe into the microphone, crumple paper, blow across a pop bottle, rattle rice in a box, hit the floor with a ruler). Select the best.

Record the story and the sound effects. Try it out on an audience to see how well you did.

Your eyes can play tricks on you too. When driving along the highway in the summer, you may have experienced a mirage that looks like a pool of water ahead of you on the hot highway The water vanishes when you came closer. Mirages like this are caused by the way light is reflected inside rising masses of hot air.

Demonstrating an optical illusion

To demonstrate a simple optical illusion, take a sheet of paper and roll it into a tube. Have the child hold the tube to one eye, keep both eyes open, and focus on an object about 15 feet away.

Now hold a small book right next to the tube in front of the eye that is not looking through the tube. Continue to focus on the distant object.

You may have to move the book a little, closer or more distant to get it into just the right position, but suddenly it will look as though you are looking at the distant object right through a hole in the book!

This happens because your eyes are set apart from one another, and when you focus on a distant object, near objects are slightly out of focus, and the image from one eye overlaps improperly from the image in the other eye.

Take advantage of the events that arise in everyday living to further explore your various senses. The resources that follow should help you find materials in areas that are of interest to your class or your curious child.

Resource books

All About Your Senses. Donna Bailey. Austin, TX: Steck-Vaughn Library, 1991. 48 pp. Explains the functions of the five senses and discusses disorders and care.

**Amazing Animal Senses.* Ron Van der Meer. Boston, MA: Joy Street Books, 1990. 12 pp. Provides facts about animal senses and includes animation glasses, action flaps, and scratch and sniff patches.

Animal Senses. Jim Flegg with Eric and David Hosking. Brookfield, CT: Newington Press, 1991. 32 pp. Discusses animal senses, locomotion, and behavior.

Animal Vision. Tony Seddon. New York, NY: Facts on File, 1988. 61 pp. Provides an overview of how different animals see and how eyes function.

Discovering Sign Language. Laura Green and Eva Barash Dicker. Washington, DC: Kendall Green Publications, 1988. 89 pp. Explains about the development of sign language.

Ear and Hearing, The. Steve Parker. New York, NY: Franklin Watts, 1991. 40 pp. Explains the anatomy of the ear.

Ears and Hearing. Doug Kincaid and Peter Coles. Vero Beach, FL: Rourke Enterprises, 1983. 24 pp. Explains how sound can be modified by the shape of the ear and discusses technical aids for hearing.

Ears Are for Hearing. Paul Showers. New York, NY: Thomas Y. Crowell, 1990. 31 pp. Explains about the process of hearing.

**Ears, Eyes and Noses.* Rachel Wright. New York, NY: Franklin Watts, 1989. 32 pp. Discusses the appearance and functions of ears, eyes, and noses in several animals, insects, and fish.

Eye and Seeing, The. Steve Parker. New York, NY: Franklin Watts, 1989. 48 pp. Introduces the reader to the sense of sight.

Eyes. Brian Ward. New York, NY: Franklin Watts, 1990. 32 pp. Explains the construction of the eye and how vision problems can be corrected.

*_Eyes._ Judith Worthy. New York, NY: Doubleday, 1989. 32 pp. Describes the eyes of several animals, in verse.

*_Eyes and Looking._ Doug Kincaid and Peter Coles. Vero Beach, FL: Rourke Enterprises, 1983. 24 pp. Explains how helpful our eyes are to us.

Feeling Things. Allan Fowler. Chicago, IL: Childrens Press, 1991. 31 pp. Discusses the sense of touch.

Fingers and Feelers. Henry Arthur Pluckrose. New York, NY: Franklin Watts, 1990. 32 pp. Examines the sense of touch in the animal kingdom including humans.

*_First Delights: A book about the five senses._ Tasha Tudor. New York, NY: Platt & Munk, 1988. 48 pp. Offers an introduction to the senses.

Five Senses, The. Jacqueline Dineen. Morristown, NJ: Silver Burdett Press, 1988. 48 pp. Provides an introduction to the five senses.

Glasses and Contact Lenses: Your guide to eyes, eyewear and eye care. Alvin and Virginia B. Silverstein. New York, NY: J. B. Lippincott, 1989. 135 pp. Explains the structure of the eyes and how to correct various visual problems.

Heads. Ron and Nancy Goor. New York, NY: Atheneum, 1988. 64 pp. Compares and contrasts the characteristics of eyes, ears, nose, and mouth in a variety of animals.

Hearing. Kathie Billingslea and Victoria Crenson. Mahwah, NJ: Troll Associates, 1988. 24 pp. Provides information on hearing in question/answer format.

Hearing. Maria Rius, J. M. Parramon, and J. J. Puig. New York, NY: Barron's, 1985. 31 pp. Explores the sense of hearing.

Hearing Loss. Karen N. Mango. New York, NY: Franklin Watts, 1991. 144 pp. Discusses hearing loss and deafness.

Hearing Things. Allan Fowler. Chicago, IL: Childrens Press, 1991. 31 pp. Discusses the sense of hearing.

Hot and Cold. Henry Pluckrose. New York, NY: Franklin Watts, 1986. 32 pp. Explains how we sense hot and cold.

Learning a Lesson: How you see, think and remember. Steve Parker. New York, NY: Franklin Watts, 1991. 32 pp. Explores the functions of the brain and nervous system and discusses how sensory experiences and information are processed.

Lenses! Take a Closer Look. Siegfried Aust. Minneapolis, MN: Lerner Publications Co., 1991. 31 pp. Looks at different lenses including a magnifying glass, telescope, microscope, and eyeglasses.

**Let's Take a Walk in The City.* Karen O'Connor. Elgin, IL: Child's World (distributed by Childrens Press), 1986. 31 pp. Tells a story of how Tony uses his five senses as he takes a walk in the city.

**Let's Take a Walk in the Park.* Deborah Crowdy. Elgin, IL: Child's World (distributed by Childrens Press), 1986. 30 pp. Betsy uses her senses as she walks in the park.

**Let's Take a Walk in the Zoo.* Jane Belk Moncure. Elgin, IL: Child's World, 1986. 32 pp. Tells a story of how Laura uses her five senses as she enjoys a visit to the zoo.

* *Let's Take a Walk on the Beach.* Karen O'Connor. Elgin, IL: Child's World (distributed by Children's Press), 1986. 31 pp. Tells a story of how a child uses his five senses as he walks along the beach.

Living with Deafness. Barbara Taylor. New York, NY: Franklin Watts, 1989. 32 pp. Discusses various forms of deafness, their causes, and treatment.

Looking at Senses. David Suzuki with Barbara Hehner. New York, NY: John Wiley & Sons, 1991. 96 pp. Discusses sight, hearing, taste, touch, and ESP.

Messengers to the Brain: Our fantastic five senses. Paul D. Martin. Washington, DC: National Geographic Society, 1984. 104 pp. Discusses the sense organs and explains how the brain and nerves process information.

**My Five Senses.* Aliki. New York, NY: Thomas Y. Crowell, 1989. 31 pp. Explains ways we use our five senses.

Nerves to Senses. Steve Parker. New York, NY: Gloucester Press, 1991. 32 pp. Explains how bodies respond to stimuli of the nervous system and outlines some related projects.

Riddles about the Senses. Jacqueline A. Ball. Morristown, NJ: Silver Burdett Press, 1989. 30 pp. Contains rhyming riddles.

Seeing. Kathie Billingslea Smith and Victoria Crenson. Mahwah, NJ: Troll Associates, 1988. 24 pp. Answers questions about the eye and how people and animals see.

Seeing in Special Ways: Children living with blindness. Thomas Bergman. Milwaukee, WI: Gareth Stevens Pub., 1989. 54 pp. Explains how other senses compensate for lost sight as told through interviews with partially sighted children.

Seeing Things. Allan Fowler. Chicago, IL: Childrens Press, 1991. 31 pp. Discusses parts of the eye and how it works.

Sense of Shabbat, A. Faige Kobre. Los Angeles, CA: Torah Aura Productions, 1989. 32 pp. Describes the process of getting ready to celebrate Shabbat as it is experienced through our five senses.

Senses, The. Mary Kittredge. New York, NY: Chelsea House Publishers, 1990. 111 pp. Explains the structure and functions of our sensory organs.

Sierra Club Wayfinding Book, The. Vicki McVey. Boston, MA: Little, Brown, 1988. 88 pp. Explains how humans develop systems using their senses and includes activities.

Sight. Maria Rius, J. M. Parramon, and J. J. Puig. Chicago, IL: Childrens Press, 1987. 32 pp. Explores the sense of sight.

Sight and Seeing: A world of light and color. Hilda Simon. New York, NY: Philomel Books, 1983. 96 pp. Explains the difference between sensitive to light and forming images and discusses importance of sight.

Smell. Maria Rius, J. M. Parramon, and J. J. Puig. Chicago, IL: Childrens Press, 1987. 31 pp. Explores the sense of smell.

Smelling. Kathie Billingslea Smith and Victoria Crenson. Mahwah, NJ: Troll Associates, 1988. 24 pp. Explores the sense of smell using a question and answer format.

Smelling Things. Allan Fowler. Chicago, IL: Childrens Press, 1991. 311 pp. Explores the sense of smell through text and photos.

Sounds. Terry J. Jennings. Chicago, IL: Childrens Press, 1989. 34 pp. Provides an introduction to sounds.

Taste. Maria Rius, J. M. Parramon, and J. J. Puig. New York, NY: Barron's, 1985. 31 pp. Contains an explanation of the sense of taste.

Taste and Smell. Doug Kincaid and Peter Coles. Vero Beach, FL: Rourke Enterprises, 1983. 24 pp. Provides an introduction to the senses of taste and smell.

Tasting. Kathie Billingslea Smith and Victoria Crenson. Mahwah, NJ: Troll Associates, 1988. 24 pp. Discusses the sense of taste using a question and answer format.

* *Tasting Things.* Allan Fowler. Chicago, IL: Childrens Press, 1991. 31 pp. Provides a simple introduction to the sense of taste.

Teach Me about Listening. Joy Wilt Berry. Chicago, IL: Childrens Press, 1988. 35 pp. Offers an introduction to the sense of hearing.

Teaching Me about Smelling. Joy Berry. Chicago, IL: Childrens Press, 1988. 34 pp. Explores the sense of smell.

Teach Me About Tasting. Joy Wilt Berry. Chicago, IL: Childrens Press, 1988. 34 pp. Provides an introduction to the sense of taste.

Teach Me about Touching. Joy Wilt Berry. Chicago, IL: Childrens Press, 1988. 35 pp. Offers an introduction to the sense of touch.

Tongues and Tasters. Henry Pluckrose. New York, NY: Franklin Watts, 1990. 32 pp. Explores the sense of taste in the animal kingdom including humans.

Too Fast To See. Kim Taylor. New York, NY: Delacorte, 1991. 24 pp. Explains about motion perception.

Too Slow to See. Kim Taylor. New York, NY: Delacorte, 1991. 24 pp. Discusses motion perception.

Touch. Maria Rius, J. M. Parramon, and J. J. Puig. New York, NY: Barron's, 1985. 29 pp. Discusses touch and includes a detailed diagram of a section of skin.

Touch and Feel. Doug Kincaid. Vero Beach, FL: Rourke Enterprises, 1983. 24 pp. Explains how fingers and skin senses shape, texture, hardness, size, weight, temperatures, and other things.

Touching. Kathie Billingslea Smith and Victoria Crenson. Mahwah, NJ: Troll Associates, 1988. 23 pp. Explores the sense of touch.

Touch, Taste and Smell. Steve Parker. New York, NY: Franklin Watts, 1989. 40 pp. Explores touch, taste, smell, and the bodily processes that contribute to these senses.

Touch—What do you feel? Nicholas Wood. Mahwah, NJ: Troll Associates, 1991. 32 pp. Explores the world of touch and how it works.

What Happens When You Listen? Joy Richardson. Milwaukee, WI: Gareth Stevens Pub. 1986. 32 pp. Explains how ears turn sounds into messages to the brain.

What Happens When You Look? Joy Richardson. Milwaukee, WI: Gareth Stevens Pub., 1986. 32 pp. Explains how eyes send visual information to the brain.

What's that I Feel? Kate Petty and Lisa Kopper. New York, NY: Franklin Watts, 1987. 22 pp. Explores the sense of touch.

Your Amazing Senses: 36 games, puzzles and tricks that show how your senses work. Ron and Atie van der Meer. New York, NY: Aladdin Books, 1987. 12 pp. Explores the senses and provides entertainment with this book's moveable parts.

Your Five Senses. Ray Broekel. Chicago, IL: Childrens Press, 1984. 45 pp. Discusses the importance of the five senses and examines the structure of the different sense organs and how they work.

You Won't Believe Your Eyes! Catherine O'Neill. Washington, DC: National Geographic Society, 1987. 104 pp. Explains visual illusions and the working of the eye-brain system.

Other resources

Exploring Human Senses (57–740–2108). Hudson, NH: Delta Education, Inc. Provides activities for middle grade students to explore their five senses. Includes hands-on materials, activity cards, guide, and storage box.

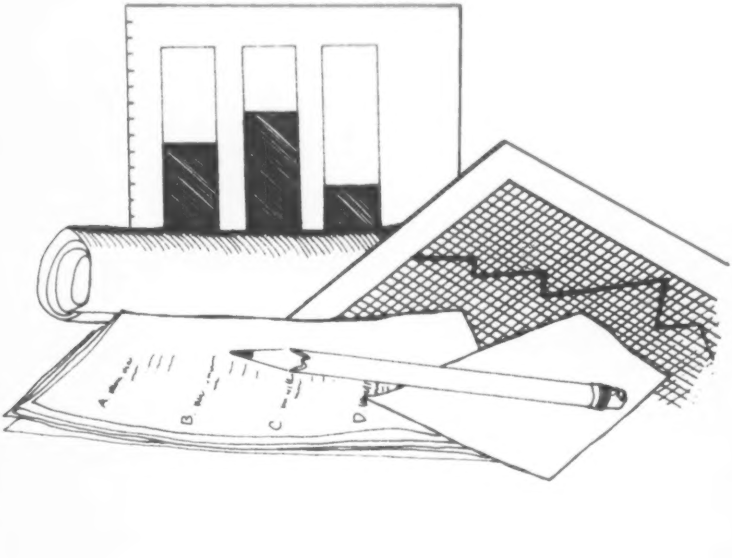
We Learn about the World. Melville, NY: Video Knowledge, Inc., 1986. 1 videocassette. Explores the senses through the investigation of size, shape, and color.

12

Exploring science through writing

Much of the information of science is communicated through writing. A classroom of students or a curious child may go to the library to find what has already been written on a topic of interest. As children learn through observations and experimentation, they may record their own findings in journals, make charts, or prepare science papers. Writing is an important tool for a scientist.

Writing can also be a means of sharing feelings and giving pleasure to writer and reader alike. Beautiful essays and poems on a variety of nature topics are in our rich heritage of literature.



Exploring poetry can begin with the youngest children. There are many delightful finger plays and nursery rhymes that tiny tots love. Often these old favorites, half forgotten, are stored in the back of an adult's memory and can easily be refreshed by reading some of the resource books listed at the end of this chapter.

Older children may have preferences for the types of poetry that they read or have had read to them. For example, some children like nature poems, others prefer humorous ones, while still others love to read poems about bears, cats, or other favorite animals. Some enjoy reading about the weather, the seashore, or the mountains, whereas others prefer the imaginative and fantastic.

The enjoyment that comes from listening to or reading poems sometimes leads to the desire to write.

Writing a lune

Lunes are an easy type of poem for many children to write. These poems are short and unrhymed, and unlike Haiku, do not require the counting of syllables. Lunes are three line poems, in any mood, on any topic, with three words in lines one and three, and five words in line two. For example:

Tiny raindrops fall
On the dusty street, washing
It sparkling clean.

An acrostic poem can tell some essentials about a science subject of interest. The following experiment is an example of how an acrostic poem can be used in science.

Telling a science acrostic

Have the child or individuals in a class write one word vertically down the paper. Then write a line of poetry for each letter in the word. The lines need not rhyme, and they can be any length, but they should have something to do with the subject of the poem. For example:

C lear and many-faced
R eadily made from sugar or salt
Y et looking like diamonds
S parkling on a string
T aken from the heart of a geode
A t last glittering out in the light
L etting everyone admire one of
S cience's great beauties.

An "I Remember" poem can also be used as a means of recollecting stages of science observations. The following experiment is an example of how an "I remember" poem can be used in science.

Using a science "I remember" poem

Have the child write three or more lines on a topic, with each line beginning with the phrase, I remember . . .. For example:

> I remember gathering the seed in a long, dark brown pod in the park.
>
> I remember thinking that the pods looked like those Jack might have traded his cow for in the old *Jack and the Beanstalk* story.
>
> I remember tearing the pods apart and pulling out the dark brown seeds.
>
> I remember planting eight seeds in a terra-cotta flower pot, and patting the soil down gently on top of each one.
>
> I remember when the first seed broke through the earth. It was pale white, bent over, and looked like a lima bean.
>
> I remember when the "bean" split and a tiny shoot climbed toward the sun.
>
> I remember when the shoot grew little leaves, a miniature of the locust tree in the park where I had found the dark brown pod.

Many poetry books have beautiful illustrations, and there are numerous children's picture books that are written in verse.

Whether you simply enjoy reading poems together or whether you and your class or your curious child decide to write some to share your love of nature and interest in science with a relative or friend, you have happy times in store as you explore poetry together.

Science reports can be very exciting. Unfortunately, many of them do not turn out that way. Children need guidance to prepare an effective report. If a classroom of students or a single child is interested in sharing some science information, it is important to discuss ways to write interesting reports. (Chapter 14 "Exploring Science in the Library" will prove helpful when writing reports.)

Too often a child comes home to an adult and says, "I have to write something about spiders or insects." The child then goes to the library and finds a book or goes to an encyclopedia and locates an article on the topic. The child ends up copying the information from one sheet of paper to another and not much is learned in the process.

Clearly, to write an interesting report, one of the first requirements is that the child cares about the topic and wants to learn more about it. Even if a "generic topic" such as insects has been given as an assignment, at least the child can decide whether to write about a tarantula or a mosquito!

A good way to approach a writing assignment is to formulate some questions. For example, if a child wants to write about a tarantula, the child might list the following questions: Where do tarantulas live? Are there different types? How big do they grow? What do they eat? Are they helpful in any way? Are they harmful in any way? Are they known for being great jumpers? Armed with a list of questions in which the child is interested, the research to prepare the science paper becomes exciting.

Next, the child needs to know that information can come from many sources. Reading about tarantulas in the encyclopedia may prove helpful, but there are also books on the topic. Maybe there are some magazine articles that have been written too. A newspaper may have carried an article about a tarantula or perhaps a local pet shop has tarantulas and the pet shop owner is willing to be interviewed. Help the child explore avenues of getting information.

Creative writing can easily be merged with science activities and experiments. One such activity is conducting the appearance of the pipe cleaners from outer space trick.

Conducting the appearance of the pipe cleaners from outer space trick

It takes some time and thought to set up the appearance of the pipe cleaners from outer space. Choose pipe cleaners of three different colors. Make some arbitrary decisions such as: White pipe cleaners are always found in pairs and are never found on the ground. In the outdoor science area you have selected, put several pair of white pipe cleaners up in bushes, on top of a fence, hanging from a sturdy plant, and other such places.

Red pipe cleaners are loners and are always found on the ground. Place a variety of red pipe cleaners on the ground throughout the area, on rocks, in the grass, at the base of a tree, and so forth.

Blue pipe cleaners are found singly, in pairs, and in groups, but are always in shady places. Place a number of blue pipe cleaners in the area both on the ground and above it, but in shady places.

Explain to the child or to the class that the pipe cleaners arrived from outer space during the night and are in a certain area near the school room or near the house. The task is to learn as much about them as possible by observing.

Have the child or children take a note tablet and pencil to the area where they will observe and make notes. Ask them not to touch or move any of the pipe cleaners.

Singly, or in groups, have the children write what they know about the pipe cleaners based on their observations. (Children may come up with some observations that the adult didn't think of when setting up the area. These are valid too.)

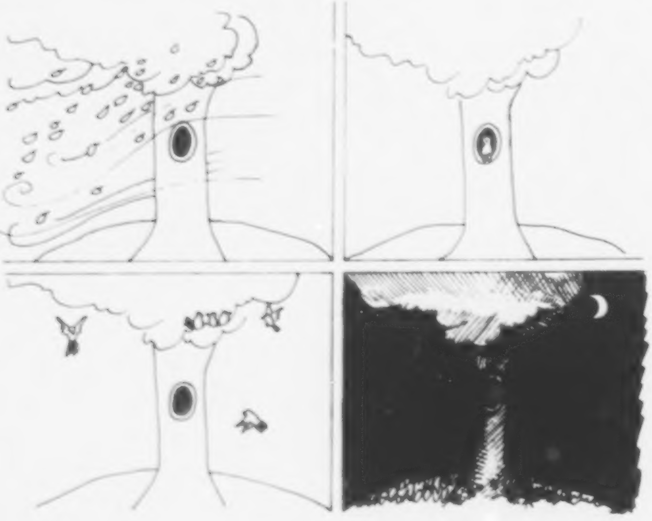
Another way of getting students to use their observation skills is to ask them to choose a favorite tree and to make observations over a period of a month.

Observing a tree

Have your curious child (or a class of students) select a tree that can be observed easily at different times of the day over a period of a month. Ask that children make at least four observations and that they write in their notebooks the date, time of observation, and everything that they noticed in and around the tree.

Sights and sounds such as wind, leaf color change, budding leaves, blossoms, insects, birds, squirrels, and so forth may appear in these notations.

Next, ask the child or students to use creative writing skills. Suppose that the tree they have been studying for a month could suddenly tell them a story. What would it say?



Writing a short story about a tree

Have the child or children refer back to the notes they have taken during their observations of a single tree. Tell them that they may add other details that they may not have observed.

Have each child write a short story, in the first person, told by the tree. Ask them to imagine how a tree might "feel" to have a bird's nest in it, to have a squirrel running up and down its trunk, to have a girl climb to its top, to have a woodpecker peck at it, to have its leaves turn colors or its blossoms, fruits, or pine cones grow.

During science/writing activities, you may also need to take time to teach some specific writing skills. Making an outline, taking notes, keeping track of information for a bibliography, and learning to conduct an interview and to quote people correctly can all come into play in science writing. Chapter 14 "Exploring Science in the Library" has additional helpful hints.

Resource books

**All Join In*. Quentin Blake. Boston, MA: Little, Brown, 1991. 30 pp. Contains six noisy poems.

Always Wondering: Some favorite poems of Aileen Fisher. Aileen Fisher. New York, NY: HarperCollins, 1991. 86 pp. Contains favorite poems.

**Animal Fair, The: Animal verses*. Compiled by Jill Bennett. New York, NY: Viking Penguin, 1990. 32 pp. Includes verses about many animals including a zoo party, the kangaroo, and the crocodile.

Anna's Summer Songs. Mary Steele. New York, NY: Greenwillow Books, 1988. 30 pp. Contains a collection of poems about plants.

**Bear Hugs*. Kathleen Hague. New York, NY: Henry Holt, 1989. 24 pp. Contains a collection of poems about teddy bears.

Beasts by the Bunches. A. Mifflin Lowe. New York, NY: Doubleday, 1987. 46 pp. Contains an illustrated collection of poems about animal groups such as a gaggle of geese.

Birds, Beasts and Fishes: A selection of animal poems. Selected by Anne Carter. New York, NY: Macmillan, 1991. 64 pp. Contains poems from around the world with illustrations.

Bird Watch: A book of poetry. Jane Yolen. New York, NY: Philomel Books, 1990. 36 pp. Contains poems about birds and their activities.

Bungalow Fungalow: Poems. Pegi Deltz Shea. New York, NY: Clarion Books, 1991. 31 pp. Contains 15 poems about a summer vacation at the beach.

Cats Are Cats. Compiled by Nancy Larrick. New York, NY: Philomel Books, 1988. 80 pp. Offers a collection of 43 poems about all kinds of cats.

* *Child's Garden of Verses, A*. Robert Louis Stevenson. San Francisco, CA: Chronicle Books, 1989. 128 pp. A new edition of a favorite book with antique pictures.

Child's Treasury of Seaside Verse, A. Compiled by Mark Daniel. New York, NY: Dial Books for Young Readers, 1991. 137 pp. Contains a collection of poems by 19th and 20th century British and Americans about the sea.

Chocolate Dreams: Poems. Arnold Adoff. New York, NY: Lothrop, Lee & Shepard Books, 1989. 63 pp. Contains poems about chocolate goodies!

* *Christmas Fox and Other Winter Poems, The*. John Bush. New York, NY: Dial Books for Young Readers, 1989. 26 pp. Contains poems about animals and winter season.

Coconut Kind of Day: Island Poems. Lynn Joseph. New York, NY: Lothrop, Lee & Shepard Books, 1990. 30 pp. Contains poems about the Caribbean Islands.

Cold Stars and Fireflies: Poems of the four seasons. Barbara Juster Esbensen. New York, NY: Thomas Y. Crowell, 1984. 70 pp. Contains a collection of nature poems by seasons.

Come on into My Tropical Garden. Grace Nichols. New York, NY: J. B. Lippincott, 1990. 38 pp. Contains poems about the people and lands of the Caribbean.

Consider the Leming. Jeanne Steig. New York, NY: Farrar, Straus & Giroux, Inc., 1988. 48 pp. Contains a collection of humorous poems.

Country Mail Is Coming, The: Poems from down under. Max Fatchen. Boston, MA: Little, Brown, 1990. 62 pp. Contains poems about the Australian countryside.

Crickets and Bullfrogs and Whispers of Thunder: Poems and pictures. Harry Behn. San Diego, CA: Harcourt Brace Jovanovich, 1984. 83 pp. Contains poems on the themes of seasons and holidays.

Dancing Teepees: Poems of American Indian youth. Selected by Virginia Driving Hawk Sneve. New York, NY: Holiday House, 1989. 32 pp. Contains poems from the oral tradition of Native Americans.

* *Day of Rhymes, A*. Selected by Sarah Pooley. New York, NY: Alfred A. Knopf (distributed by Random House), 1987. 75 pp. Contains an illustrated collection of Mother Goose and other nursery rhymes.

Dinosaur Dances. Jane Yolen. New York, NY: G. P. Putnam's Sons, 1990. 39 pp. Contains 17 whimsical poems.

Dinosaurs: Poems. Selected by Lee Bennett Hopkins. San Diego, CA: Harcourt Brace Jovanovich, 1987. 46 pp. Contains 18 poems about dinosaurs.

Dog's Life, A: Poems. Selected by Lee Bennett Hopkins. San Diego, CA: Harcourt Brace Jovanovich, 1983. 40 pp. Contains 23 poems about dogs.

Earth Songs. Myra Cohn Livingston. New York, NY: Holiday House, 1986. 32 pp. Contains poems that pay tribute to earth.

Earth Verses and Water Rhymes. J. Patrick Lewis. New York, NY: Atheneum, 1991. 32 pp. Contains poems about our natural world.

**Eric Carle's Animals, Animals*. Compiled by Laura Whipple. New York: Philomel Books, 1989. 87 pp. Contains illustrations around a collection of poems on wild and domestic animals by various authors.

**Eric Carle's Dragons, Dragons and Other Creatures that Never Were*. Compiled by Laura Whipple. New York, NY: Philomel Books, 1991. 68 pp. Contains poems by many authors with beautiful illustrations.

For Laughing Out Loud: Poems to tickle your funnybone. Selected by Jack Prelutsky. New York, NY: Alfred A. Knopf, 1991. 84 pp. Contains a collection of humorous poems by many authors.

Four and Twenty Dinosaurs. Bernard Most. New York, NY: Harper & Row, 1990. 32 pp. Contains nursery rhymes in which dinosaurs have been substituted for the traditional main characters.

Ghosts and Goosebumps: Poems to chill your bones. Selected by Bobbi Katz. New York, NY: Random House, 1991. 32 pp. Contains many scary poems.

**Glorious Mother Goose, The*. Selected by Cooper Edens. New York, NY: Atheneum, 1988. 88 pp. Contains a collection of nursery rhymes.

Goosebumps & Butterflies. Yolanda Nave. New York, NY: Orchard Books, 1990. 31 pp. Contains poems about fears and anxieties.

Granny, Will Your Dog Bite and Other Mountain Rhymes. Gerald Milnes. New York, NY: Alfred A. Knopf, 1990. 45 pp. Contains poems about mountain life.

Grass Green Gallop, A: Poems. Patricia Hubbell. New York, NY: Atheneum, 1990. 48 pp. Contains poems about horses.

Hailstones and Halibut Bones: Adventures in color. Mary O'Neill. New York, NY: Doubleday, 1989. 62 pp. Contains 12 poems about different colors.

Halloween Poems. Selected by Myra Cohn Livingston. New York, NY: Holiday House, 1989. 30 pp. Contains 18 Halloween poems.

Hard-Boiled Legs. Michael Rosen. New York, NY: Prentice-Hall Books for Young Readers, 1987. 20 pp. Contains poetry and prose about the hazards of breakfast time.

**Here's a Ball for Baby: Finger rhymes for young children.* Illustrated by Jenny Williams. New York, NY: Dial Books for Young Readers, 1987. 19 pp. Contains several finger plays.

Hippopotamusn't and Other Animal Verses, A. J. Patrick Lewis. New York, NY: Dial Books for Young Readers, 1990. 40 pp. Contains more than 30 funny animal poems.

House of a Mouse The,: Poems. Aileen Fisher. New York, NY: Harper & Row, 1988. 31 pp. Contains poems about mice.

How to Read and Write Poems. Margaret Ryan. New York, NY: Franklin Watts, 1991. 63 pp. Explains some of the basic concepts of poetry and gives suggestions for beginning to write it.

Hurry, Hurry, Mary Dear! And other nonsense poems. N. M. Bodecker. New York, NY: Margaret K. McElderry Books, 1986. 118 pp. Contains nonsense poems with many pen sketches.

If the Owl Calls Again: A collection of owl poems. Selected by Myra Cohn Livingston. New York, NY: Margaret K. McElderry Books, 1990. 114 pp. Contains poems by different authors about owls.

If You're Not Here, Please Raise Your Hand: Poems about school. Kalli Dakos. New York, NY: Four Winds Press, 1990. 60 pp. Contains illustrated poems about experiences in school.

I Hear America Singing. Walt Whitman. New York, NY: Philomel Books, 1991. 32 pp. Contains Whitman's famous poems with linoleum-cut illustrations.

I Like You, If You Like Me: Poems of friendship. Selected by Myra Cohn Livingston. New York, NY: Margaret K. McElderry Books, 1987. 144 pp. Contains 90 poems by both traditional and contemporary poets.

I'm Going to Pet a Worm Today, and Other Poems. Constance Levy. New York, NY: Margaret K. McElderry Books, 1991. 38 pp. Contains 39 poems about everyday things.

In Fall. Rochelle Nielsen-Barsuhn, Jane Belk Moncure, and Eleanor Hammond. Elgin, IL: Child's World (distributed by Childrens Press), 1985. 31 pp. Contains a collection of autumn poems.

In Spring. Jane Belk Moncure. Elgin, IL: Child's World (distributed by Childrens Press), 1985. 31 pp. Contains a collection of spring poems.

In Summer. Jane Belk Moncure and Aileen Fisher. Elgin, IL: Child's World (distributed by Children's Press), 1985. 31 pp. Contains a collection of poems about summer.

In Winter. Jane Belk Moncure. Elgin, IL: Child's World (distributed by Childrens Press), 1985. 31 pp. Contains a collection of fifteen winter poems.

***I See the Moon: Good night poems and lullabies*. Selected by Marcus Pfister. New York, NY: North-South Books, 1991. 26 pp. Contains traditional lullabies and poems.

January Brings the Snow. Sara Coleridge. New York, NY: Simon & Schuster, 1987. 26 pp. Contains poems for each month of the year.

Joyful Noise: Poems for two voices. Paul Fleischman. New York, NY: Harper & Row, 1988. 44 pp. Contains poems about a variety of insects.

***Laughing Baby, The: Remembering nursery rhymes and reasons*. Anne Scott (Editor). South Hadley, MA: Bergin & Garvey, 1987. 116 pp. Contains a collection of nursery rhymes, finger plays, and physical activities to do with music.

Laughing Time: Collected nonsense. William Jay Smith. New York, NY: Farrar, Straus & Giroux, Inc., 1990. 163 pp. Contains nonsense poems.

Make a Joyful Sound: Poems for children by African American poets. Illustrated by Cornelius Van Wright and Ying-Hwa Hu. New York, NY: Checkerboard Press, 1991. 97 pp. Contains poems by Afro-American poets.

***Midnight, Farm, The*. Reeve Lindberg Brown. New York, NY: Dial Books for Young Readers, 1987. 25 pp. Contains poems about a farm at midnight.

Mockingbird Morning. Joanne Ryder. New York, NY: Four Winds Press, 1989. 32 pp. Contains poems around the theme of an early morning walk.

Mojave. Diane Siebert. New York, NY: Thomas Y. Crowell, 1988. 32 pp. Contains poems about the land and animals of the Mojave Desert.

Moment in Rhyme, A. Colin West and Julie Banyard. New York, NY: Dial Books for Young Readers, 1987. 30 pp. Contains 24 poems with illustrations.

***My Favorite Nursery Rhymes*. Collected by Linda Yeatman. New York, NY: Little Simon, 1987. 125 pp. Contains more than 150 rhymes.

***My First Halloween Book*. Colleen L. Reece. Chicago, IL: Childrens Press, 1984. 31 pp. Contains poems about witches, trick-or-treats, and Halloween related things.

Nathaniel Talking. Eloise Greenfield. New York, NY: Writers & Readers Publishing for Black Butterfly Childrens Books, 1988. 32 pp. Contains poems by Afro-American authors.

Nonsense Verse of Edward Lear, The. Edward Lear. New York, NY: Harmony Books, 1984. 234 pp. Contains a collection of 236 limericks and nonsense poems.

Once Inside the Library. Barbara A. Huff. Boston, MA: Little, Brown, 1990. 32 pp. Contains poems about the joy of reading and books.

**One, Two, Buckle My Shoe: Counting rhymes for young children*. Illustrated by Jenny Williams. New York, NY: Dial Books for Young Readers, 1987. 19 pp. Contains many favorite counting rhymes.

**On the Farm: Poems*. Selected by Lee Bennett Hopkins. Boston, MA: Little, Brown, 1991. 32 pp. Contains poems about farm animals.

Paper Zoo, A: A collection of animal poems by modern American poets. Selected by Renee Karol Weiss. New York, NY: Macmillan, 1987. 38 pp. Contains poems by well-known American poets.

People Poems. Collected by Jill Bennett. New York, NY: Oxford University Press, 1990. 28 pp. Contains illustrations and funny poems about people.

**Play Rhymes*. Marc Tolon Brown. New York, NY. Dutton, 1987. 32 pp. Contains 12 finger plays and rhymes.

Poems for Brothers, Poems for Sisters. Selected by Myra Cohn Livingston. New York, NY: Holiday House, 1991. 32 pp. Contains poems about brothers and sisters written by a variety of poets.

**Pussycat Ate the Dumplings: Cat rhymes from Mother Goose*. Compiled by Robin Michal Koontz. New York, NY: Dodd, Mead, 1987. 47 pp. Contains cat poems.

**Ride a Cockhorse: Animal rhymes for young children*. Illustrated by Jenny Williams. New York, NY: Dial Books for Young Readers, 1987. 20 pp. Contains nursery rhymes about animals.

**Riddles about Baby Animals*. Jacqueline A. Ball and Ann D. Hardy. Morristown, NJ: Silver Burdett Press, 1989. 30 pp. Contains rhyming riddles about baby animals.

Seasons. Warabe Aska. New York, NY: Doubleday, 1990. 44 pp. Contains poems about the four seasons.

Snow toward Evening: A year in a river valley. Selected by Josette Frank. New York, NY: Dial Books for Young Readers, 1990. 32 pp. Contains poems about nature.

Space Songs. Myra Cohn Livingston. New York, NY: Holiday House, 1988. 32 pp. Contains poems and illustrations of outer space.

Spin a Soft Black Song: Poems for children. Nikki Giovanni. New York, NY: Hill and Wang, 1985. 57 pp. Contains a collection of poems that recounts the experiences and feelings of black children.

Still as a Star: A book of nighttime poems. Selected by Lee Bennett Hopkins. Boston, MA: Little, Brown, 1989. 31 pp. Contains 15 poems by well-known poets.

Strawberry Drums: A book of poems with a beat for you and all your friends to keep. Selected by Adrian Mitchell. New York, NY: Delacorte, 1991. 39 pp. Contains 30 poems from all over the world.

* *Tails, Claws, Fangs, and Paws: An alphabeast caper.* Terry Small. New York, NY: Bantam, 1990. 32 pp. Contains a rhyming text with animals for each letter of the alphabet.

* *Tasha Tudor's Bedtime Book.* Kate Kline (Editor). New York, NY: Platt & Munk, 1988. 43 pp. Contains poems to read at bedtime.

* *Teddy Bear's Picnic, The.* Jimmy Kennedy. New York, NY: P. Bedrick Books, 1987. 24 pp. Tells the familiar teddy bear song.

* *Ten Potatoes in a Pot and Other Counting Rhymes.* Selected by Michael Jay Katz. New York, NY: Harper & Row, 1990. 32 pp. Contains popular and little known rhymes.

Tiger Brought Pink Lemonade, The. Patricia Hubbell. New York, NY: Atheneum, 1988. 32 pp. Contains poems about both real and fantastic animals.

Time Is the Longest Distance: An anthology of poems. Selected by Ruth Gordon. New York, NY: HarperCollins, 1991. 74 pp. Contains many poems about time.

To the Moon and Back: A collection of poems. Compiled by Nancy Larrick. New York, NY: Delacorte Press, 1991. 84 pp. Contains 66 poems by dozens of authors.

Trees: A poem. Harry Behn. New York, NY: Henry Holt, 1992. 30 pp. Celebrates the importance of trees.

* *Trot, Trot to Boston: Play rhymes for baby.* Compiled by Carol F. Ra. New York, NY: Lothrop, Lee & Shepard Books, 1987. 31 pp. Contains rhymes and instructions for doing finger plays.

Turtle in July. Marilyn Singer. New York, NY: Macmillan, 1989. 32 pp. Consists of poems that depict animals each month of the year.

Tyrannosaurus Was a Beast: Dinosaur poems. Jack Prelutsky. New York, NY: Greenwillow Books, 1988. 31 pp. Contains humorous poems about dinosaurs.

Under the Sunday Tree: Poems. Eloise Greenfield. New York, NY: Harper & Row, 1988. 38 pp. Contains poems and pictures about life in the Bahamas.

Up in the Air. Myra Cohn Livingston. New York, NY: Holiday House, 1989. 32 pp. Contains poems that express the feelings of being up in an airplane.

Voices on the Wind: Poems for all seasons. Selected by David Booth. New York, NY: Morrow Junior Books, 1990. 40 pp. Contains poems about the seasons.

Water Pennies and Other Poems. N. M. Bodecker. New York, NY: Margaret K. McElderry Books, 1991. 51 pp. Contains poems about several different small creatures such as snails and moths.

Way I Feel—Sometimes, The. Beatrice Schenk de Regmiers. New York, NY: Clarion Books, 1988. 48 pp. Contains poems about the ways people feel.

* *Week of Lullabies, A*. Helen Plotz (Editor). New York, NY: Greenwillow Books, 1988. 31 pp. Offers an illustrated collection of lullabies and bedtime poems grouped by days of the week.

What I Did Last Summer. Jack Prelutsky. New York, NY: Greenwillow Books, 1984. 47 pp. Contains poetry about children in the summer.

Whiskers and Paws. Fiona Waters (Editor). New York, NY: Interlink Publishing, 1990. 29 pp. Contains poems that feature animals.

Who's Been Sleeping in My Porridge? A book of silly poems and pictures. Colin McNaughton. Nashville, TN: Ideals Children's Books, 1990. 90 pp. Contains many comical poems.

Wind in the Long Grass: A collection of haiku. William J. Higginson (Editor). New York, NY: Simon & Schuster Books for Young Readers, 1991. 48 pp. Contains haiku from all over the world.

* *Wynken, Blynken, and Nod and Other Bedtime Poems*. Linda C. Falken (Editor). New York, NY: Golden Books (distributed by Western Publishing Co.), 1987. 45 pp. Contains poems about sleep and night by English and American poets.

You Be Good and I'll Be Night. Eve Merriam. New York, NY: Morrow Junior Books, 1988. 38 pp. Contains many short rhymes.

Zoo Doings: Animal poems. Jack Prelutsky. New York, NY: Greenwillow Books, 1983. 79 pp. Contains 46 animal poems.

Other resources

American History in Verse. Greg Beeson (Director). Universal City, CA: MCA HomeVideo, 1986. 3 videocassettes, 90 minutes. Contains legends, verse, and fables from our history.

Christmas Poems for You and Me. Richard Laurent (Producer). Chicago, IL: Encyclopedia Britannica Educational Corp., 1988. 1 book, 7 pp.; 1 videocassette, 5 minutes. Contains Christmas poems.

Holiday Poems for December. Richard Laurent (Producer). Chicago, IL: Encyclopedia Britannica Educational Corp., 1988. 1 book, 10 pp.; 1 videocassette, 6 minutes. Contains eight short presentations about three December holidays including Hanukkah and Kwanza.

13

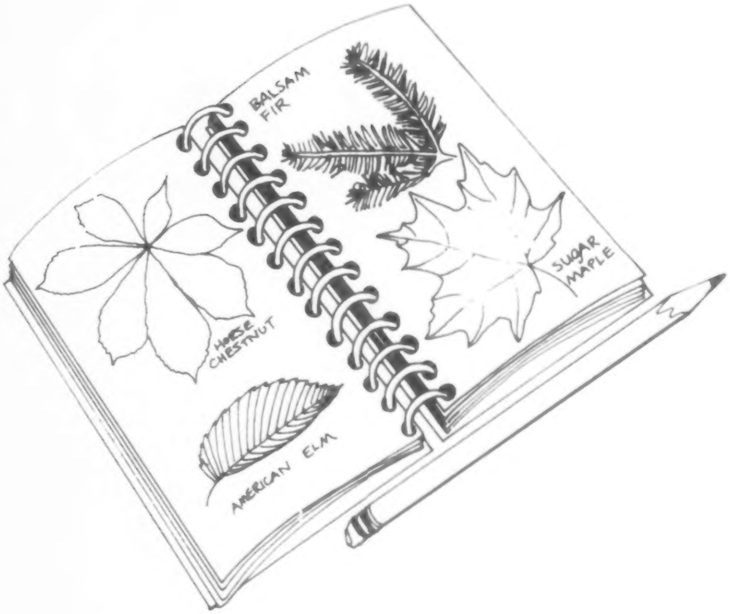
Exploring science through art

Some people believe the worlds of "science" and "art" to be poles apart. This is not the case. The trained eye of the artist and the scientist may be very similar in their search for details and in their appreciation of symmetry, shape, color, texture, and pattern. Art can certainly be a means of deepening science appreciation and of communicating information.

An interested child or a class of students going on a hike to observe the autumn color changing of leaves, to identify songbirds, to study different types of conifers, or locate native wildflowers might do well to take along artist's sketch pads. For example, a careful sketch of a leaf, showing a bulging down on one side of the leaf base, will help the student know that he or she has identified a hackberry rather than an American Elm. Noting that the cones are prickly and sketching a bundle of only two pine needles that are 1 inch to 3 inches long will help identify whether a tree is a lodgepole or tarmac pine. Noticing the rusty orange patch on the back of a bird will separate the gray-headed junco from the slate-colored junco.

You may think that sketching is unnecessary, that you will remember what you see, but after a full day of hiking and observing, adults as well as children forget many details and become confused when trying to recall specifics. The sketch pad is very helpful to the young scientist, even if its only a tiny spiral pad that slips easily into a pocket.

In addition to sketching in the field, there are opportunities of presenting science material in charts and graphs that can also involve artistic skills. Many a science fair project would be more impressive if, in addition to the thoughtful hypothesis, data, and demonstration,



the presentation of the print materials was pleasing to the eye, well-spaced, and easy to read.

Sometimes, gathering material from fields and woods can be used in an interesting arts and crafts project. A nature mobile provides an artistic means of studying balance. On a hike to an area where it is acceptable to gather objects, have children collect small items that are of interest to them. Such objects might include a small pine cone, a branch with a piece of lichen on it, a colorful rock, a seed pod, a dried leaf, and any other small object that may be of interest to the children. Then provide time to construct the mobile.

Making a nature mobile

Tie a short loop of sturdy black carpet thread to the middle of a piece of wire that is about 8 inches long. This loop will hold up your finished mobile. Tie three other pieces of black carpet thread from the wire and let them hang down. Use the middle thread of these three pieces to tie to another piece of wire that is about 10 inches long. Tie two more pieces of carpet thread to this 10-inch wire.

Hook your loop on something so that the wires and strings hang down. Experiment with tying different objects to the four strings that hang down. You are trying to keep them in balance so that the two wires will hang in a horizontal position. For example, a twig with a piece of lichen on it may balance with a long, milkweed pod. A small pine cone may balance with a weathered piece of tree root.

The finished mobiles may hang from a light fixture, a plant hook, classroom ceiling lights, or any other place where it has enough room to hang.

If you can gather small, colorful leaves from a nature hike in the fall, you can use these materials to make interesting and decorative bookmarks.

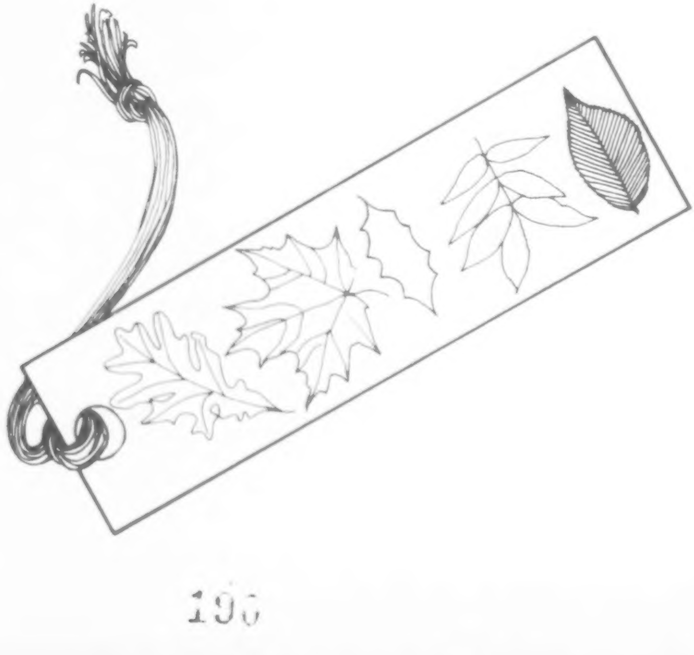
Creating leaf bookmarks

Gather ½ dozen small, colorful autumn leaves. Arrange them on a strip of waxed paper that is 3 inches wide by 8 inches long.

Put another piece of waxed paper over the leaf arrangement.

Use an ironing board and a moderately hot iron to melt the edges of the two pieces of waxed paper together. Go close to the leaf, but not over it with the iron.

Trim the bookmark and it is ready for use. You may want to use a punch to make a hole near the top where you can add a braided yarn string.

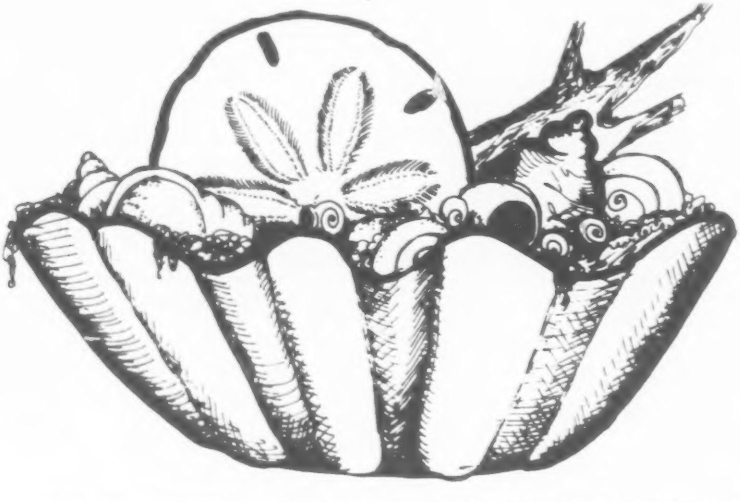


If, instead of living near the woods, you spend time exploring along the seashore, you can use shells that you gather for a variety of interesting art/science projects.

Assembling a shell garden

Take a walk along the beach to collect large clam shells. Also gather other pretty small shells, pieces of dried seaweed, and bits of driftwood.

Use the large shell for the base of your garden. Put a layer of clay into the shell. Press into the clay the objects that you gathered to make a miniature seascape garden. The driftwood will resemble a small tree. The seaweed will look like plant life. Sand dollars, shells, and other items you find will add to the scene.



You might want to cover the clay ground with a thin layer of sand so that it resembles the beach.

Inviting parents or friends to come to a science fair or to see a classroom display of projects could involve designing an artistic, personalized invitation. You might include an original sketch of a tree, flower, or mountain on the front of the invitation. The invitations can be photocopied or individually hand-crafted with a leaf or fern print on the front.

Making a fern print

Take a small fern leaf and press it overnight between two sheets of blotting paper.

Cut and fold paper to the size you wish for your finished invitation.

Place the pressed fern on the front of the invitation. Use an old toothbrush dipped into paint for your paint brush. Rub the toothbrush filled with paint over a fine mesh screen held about 6 inches above the fern. It will splatter the paint all around the area not covered by the fern. (You can splatter with more than one color if you wish.)

Remove the fern and you have the outline of the fern on your invitation. Because the paint will splatter beyond the invitation, be sure to cover the surface on which you are working to allow for easy clean up, and have the child wear a paint shirt to protect his or her clothes.

Even though you may immediately see ways in which "arts and crafts" can play a role in science studies, you may still shudder and maintain you can't do anything the least bit artistic. This is simply not true. While it's a fact that not everyone is a great painter, a fabulous quilter, or an accomplished sketcher, it is a rare individual indeed who does not have some skill that will be useful in arts and crafts.

Can you trace you hand? Fold a piece of paper? Take a photo? Sew on a button? Glue a pine cone? Cut out an airplane wing? If so, there are crafts you can do and that you can help children to do successfully!

Folding paper can yield interesting craft projects of many kinds. There are numerous books on making paper airplanes that can challenge the youngest to oldest reader.

Experimenting with paper airplanes

Take a wooden clothespin. Cut the wing for an airplane from light weight cardboard. Decorate the wing with your favorite designs or paint it a bright color.

Slide the decorated airplane wing into the clothespin and wedge it into place with a toothpick or bits of cardboard. Have fun seeing how far it will glide. Experiment with different lengths and widths of the wing.

There are many books on folding light-weight paper airplanes. If you are studying aerodynamics, you might want to hold a paper airplane day. Number the planes so that you can keep simple but accurate records.

Give students time to try out a variety of designs. Number the planes so that you can keep simple but accurate records. Then go outside with a stop watch and tape measure. Clock to see how long and how far different planes will glide.

Shadows are often a topic of science study, and they are very intriguing to students. You may conduct a series of experiments using a sundial to measure time (see Chapter 7 "Exploring Astronomy"). Perhaps you will measure the shadow of an object placed in the same spot at different times of the day. This interest in studying shadows in science might lead you to want to do shadow portraits as an art project.

Creating shadow portraits

Shadow portraits are both easy and fun to make. Tape a piece of white construction paper to the wall. Have the subject sit in a chair in front of the paper with one shoulder toward the paper.

Shine a bright light on the subject so that a sharp shadow of his or her silhouette falls on the paper. Turn off the other lights in the room. Trace the shadow onto the paper.

Then put a piece of black construction paper behind the white sheet on which you've drawn the outline. Cut through both sheets of paper. You will now have a black silhouette that can be signed, dated, and framed. It makes a great gift for a child to give a special friend or relative!

Children often are quicker than adults to use one idea as a springboard for another. Encourage these far-ranging artistic explorations. Providing the time, materials, and a place to work may be the adult's main contribution to the arts and crafts projects.

And let's face it—arts and crafts can be messy. It's a good idea to have some boxes where basic supplies are kept. A sturdy cardboard box could hold such items as: scissors, ruler, needles and thread, stapler, gummed tape, paste, glue, tape measure, and any other pertinent material. Putting balls of yarn in another box with a lid, punching a number of holes in the lid, and threading the yarn out through the holes, puts a variety of colored yarns into availability without a tangle of knots. Yet another box may be home for ribbons, buttons, pine cones, nut cups, corks, walnut shells, and other small objects.

Depending upon the extent to which you want to be involved in arts and crafts, a box where large paper can be stored flat may also prove helpful. You might purchase a package of 12–x–18-inch colored construction paper and store the sheets in the paper box along with pieces of cardboard and packages of crepe paper. Tempera paints, brushes, and magic markers are also useful supplies to have on hand.

Some adults and children enjoy working with clay. Although many fine ceramics require baking in a kiln and special glazes, there are also simple clay crafts to make such as coil pots decorated with tempera paint and filled with dried wild flowers. Modeling clay can be used over and over to form and reform wild animals or zoo animals.

Taking a trip to the zoo

Give each child a lump of modeling clay. Invite the student to model a favorite animal. Remind them that it works best to pull the legs, arms, trunks, and head out from the lump of clay rather than making little clay pieces and trying to stick them to the body.

Allow time for experimentation. Have magazine pictures of various zoo animals posted so that the child or class of students can look at them as they attempt their models.

Then make a zoo using shoe boxes, straws, and clay animals. Cut a "window" in the lid of a shoe box, about 1 inch from the edge on all sides.

Turn the shoebox on its side, and put the clay animal into the shoe box. Use striped plastic straws to make bars for the cage. Cut the straws so that they are 1 inch taller than the shoebox. Flatten the ends of the straws and tape them at the top and bottom at 2-inch intervals in front of the clay animal.

Put the lid back on the box and tape the lid in place. Make several, place them in a row, and you'll have a zoo.

You, or a child close to you, may be especially interested in photography, film strip making, or video recording. Some resources are listed at the end of this chapter that may be helpful in expanding on these artistic hobbies.

Today we also find a lot of "wearable art." You may want to use pens with washable inks or experiment with knots and dyes to create a fabulous T-shirt. This can be done in celebration of completing a hike or a camping trip and the art can depict a favorite nature scene.

If having lots of arts and crafts supplies on hand sounds disheartening to you, don't despair! Many of the resources listed require items that can commonly be found around the house, such as egg cartons, clothes pins, empty food containers, toothpicks, popcorn, and the like. Teachers can send home a list of wanted materials and have families donate supplies. Other projects require things that can be found on a hike in the woods, such as the mobile previously described that is made of twigs, pods, and leaves. Remember that arts and crafts can be as simple or as complicated as you want.

Using art to communicate science learnings is an effective and interdisciplinary approach to learning.

Resource books

Adventures in Art: Art and craft experiences for 7–11-year-olds. Susan Milord. Charlotte, VT: Williamson Publishing Company, 1990. 158 pp. Contains historical information and 100 activities involving printmaking, wearable art, portraiture, and sculpture.

Are Those Animals Real?: How museums prepare wildlife exhibits. Judy Cutchins and Ginny Johnston. New York, NY: Morrow Junior Books, 1984. 75 pp. Gives an introduction to the methods and materials used by museum artists.

Arts and Crafts: From things around the house. Imogene Forte. Nashville, TN: Incentive Publications, 1983. 79 pp. Describes easy-to-make projects such as popcorn pictures, tie-dyed T-shirts, and a wishbone key ring.

At the Zoo. Editors of *Better Homes and Gardens.* Des Moines, IA: Meredith Corp., 1989. 32 pp. Offers ideas for zoo handicrafts.

**Balloon Sculpturing for Beginners.* Bruce Fife. Bellaire, TX: Java Publishing Co. 1988. (Unpaged.) Contains easy-to-follow directions for making animals and other items from balloons.

Bats, Butterflies, and Bugs. St. Clair Adams Sullivan. Boston, MA: Little, Brown, 1990. 79 pp. Includes instructions for making toys that look like bats, butterflies, and bugs.

Cards. Clare Beaton. New York, NY: Warwick Press, 1990. 24 pp. Gives step-by-step instructions for making a variety of greeting cards.

**Child's Play: 200 instant crafts and activities for preschoolers.* Leslie Hamilton. New York, NY: Crown Publishers, 1989. (Unpaged.) Contains a collection of crafts, games, and activities.

Clayworks: Colorful crafts around the world. Virginie Fowler. New York, NY: Prentice-Hall Books for Young Readers, 1987. 150 pp. Gives instructions on making clay objects from cultures both ancient and modern.

Colors. Philip Yenawine. New York, NY: Delacorte, 1991. 22 pp. Uses examples to examine the element of color and how it helps to convey feelings in art.

*_Color Zoo._ Lois Ehlert. New York, NY: J. B. Lippincott, 1989. 28 pp. When placed on top of one another, the colors and shapes in this book illustrate animal faces.

Craft Painting Fun. Carolyn Davis. Tustin, CA: Walter Foster Publishing, 1991. 63 pp. Describes painting craft objects.

*_Creative Egg Carton Crafts._ Nancy McClure and Janis Rhodes. Carthage, IL: Good Apple, 1991. 64 pp. Describes how to turn egg cartons into dinosaurs and caterpillars.

Creative Food Box Crafts. Nancy Giles. Carthage, IL: Good Apple, 1991. 64 pp. Contains ideas for making simple gifts and musical instruments for children from preschool to second grade.

Draw, Design and paint: Projects designed to foster individual expression in the visual arts. Jan Barry. Carthage, IL: Good Apple, 1990. 140 pp. Contains art projects in a fun-filled activity book format.

Draw 50 Sharks, Whales, and Other Sea Creatures. Lee J. Ames with Warren Budd. New York, NY: Doubleday, 1989. 64 pp. Shows how to draw sea creatures step-by-step.

Drawing. Anthony Hodge. New York, NY: Gloucester Press, 1991. 32 pp. Gives a variety of opportunities for projects on line, light and shadow, and personal expression.

Draw Fifty Monsters, Creeps, Superheroes, Demons, Dragons, Nerds, Dirts, Ghouls, Giants, Vampires, Zombies, & Other Curiosa. Lee J. Ames. New York, NY: Doubleday, 1986. 64 pp. Shows how to draw many strange creatures.

Drawing Life in Motion. Jim Arnosky. New York, NY: Lothrop, Lee & Shepard Books, 1984. 46 pp. Shows how to give the effect of motion in your drawings.

Free and Inexpensive Arts & Crafts to Make and Use. Nancee McClure. Carthage, IL: Good apple, 1987. 112 pp. Contains at least 10 craft ideas for each month of the year.

*_Handicrafts._ Rosie Wermert. New York, NY: Random House, 1989. 32 pp. Contains 20 fun and easy projects you can make by tracing your hand.

*_Hand-Shaped Gifts: Handmade gifts from little fingers._ Diane Ronica. Carthage, IL: Good Apple, 1991. 138 pp. Consists of crafts for children from preschool through fourth grade using hands as the basis for crafts.

Holiday Patterns. Jean Warren. Everett, WA: Warren Publishing, 1991. 237 pp. Contains a guide to a variety of handicrafts including paper work and decorations.

How to Draw Zoo Animals. Jocelyn Schrieber. Mahwah, NJ: Watermill Press, 1988. 32 pp. Suggests different drawing techniques.

How to Make Your Own Video. Perry Schwartz. Minneapolis, MN: Lerner Publications Co., 1991. 72 pp. Tells how to use a camcorder and make home videos.

I Like Painting. Melanie and Chris Rice. New York, NY: Warwick Press, 1989. 44 pp. Provides an introduction to painting.

**Kids Create: Arts and crafts experiences for 3-to-9-year-olds.* Laurie Carlson. Charlotte, VT: Williamson Publishing Company, 1990. 158 pp. Contains easy-to-follow instructions for 150 different craft activities.

Kidvid: Fun-damentals of video instruction. Kaye Black. Tucson, AZ: Zephyr Press, 1989. 96 pp. Shows children in nine lessons the basics of video production.

Lines. Philip Yenawine. New York, NY: Delacorte, 1991. 22 pp. Isolates the element of lines and examines how lines are central to art.

Make Your Own Animated Movies and Videotapes: Film and video techniques from the yellow ball workshop. Yvonne Anderson. Boston, MA: Little, Brown, 1991. 176 pp. Contains instructions for making animated movies, operating a camera, and synchronizing sound.

Making Toys and Gifts. Stefan Lemke. Chicago, IL: Childrens Press, 1991. 80 pp. Gives instructions for many projects for kids who are age 8 or older.

Masks. Clare Beston. New York, NY: Warwick Press, 1990. 24 pp. Gives instructions in how to make masks.

Meet Matisse. Nelly Munthe. Boston, MA: Little, Brown, 1983. 45 pp. Provides an introduction to cut-outs with instructions for several different techniques.

More Dinosaurs! And Other Prehistoric Beasts: A drawing book. Michael Emberley. Boston, MA: Little, Brown, 1983. 58 pp. Shows how to draw dinosaurs.

More than Sixty Projects for Kids. Pat Roberts. Scotts Valley, CA: Mark Publishing, 1991. (Unpaged.) Contains a guide for parents/teachers to assist kids in making 60 projects.

My Camera: At the zoo. Janet Perry Marshall. Boston, MA: Little, Brown, 1989. 30 pp. Offers a crazy look at animals, first seen askew, and then clearly through a camera lens.

My First Camera Book. Anne Kostick. New York, NY: Workman Pub., 1989. 51 pp. Gives tips for taking pictures, making postcards, and so on, through a story of how Teddy Bear Bialosky shares.

Nature in Art. Anthea Peppin. Brookfield, CT: Millbrook Press, 1992. 48 pp. Shows different techniques used by artists to depict nature.

Painting. Anthony Hodge. New York, NY: Gloucester Press, 1991. 32 pp. Describes painting techniques and explores portraiture, still life, landscapes, and surrealism.

Paper. Erica Burt. Vero Beach, FL: Rourke Enterprises, 1990. 32 pp. Gives instructions for projects using paper or cardboard and folding, curling, cutting, or tearing.

Photography. David Cumming. Austin, TX: Steck-Vaughn Library, 1989. 48 pp. Gives an overview of British and American photography as art and discusses photography as a career.

Photography. Duncan Fraser. New York, NY: Bookwright Press, 1987. 32 pp. Tells how cameras were invented, their history, and how to choose a camera.

Photography: Take your best shot. Terri Morgan and Shmuel Thaker. Minneapolis, MN: Lerner Publications Co., 1991. 72 pp. Gives practical techniques for photography and discusses dark-room skills.

Playing with Plasticine. Barbara Reid. New York, NY: Morrow Junior Books, 1988. 95 pp. Explains how to turn plasticine into flat pictures and three-dimensional objects.

Projects for Autumn and Holiday Activities. Joan Jones. Ada, OK: Garrett Educational Corp., 1989. 31 pp. Contains autumn arts and crafts projects.

See-Through Zoo, The: How glass animals are made. Suzanne Haldane. New York, NY: Pantheon Books, 1984. 37 pp. Gives an introduction to glass art.

Shapes. Philip Yenawine. New York, NY: Delacorte, 1991. 22 pp. Isolates shape as an aspect of art, and explains the visual ideas that can be conveyed by use of shapes.

Sketching Outdoors in autumn. Jim Arnosky. New York, NY: Lothrop, Lee & Shepard Books, 1988. 48 pp. Contains ideas for outdoor Fall sketching.

Television and Video. Ian Graham. New York, NY: Gloucester Press, 1991. 32 pp. Tells how TV and various pieces of video equipment work.

Terrific Paper Toys. Elmer Richard Churchill. New York, NY: Sterling Publishing Co., 1991. 128 pp. Tells how to make items from paper such as toys, hats, puppets, and flowers.

Things to Do. Editors of Time-Life Books. Alexandria, VA: Time-Life Books, 1989. 87 pp. Contains projects to make such as seashell mobiles, paper airplanes, peanut puppets, and other fun items in a question/answer format.

Time Out Together: A month-by-month guide to activities to enjoy with your children. Jan Brennan. Little Rock, AS: August House Publishers, 1990. 173 pp. Contains creative activities.

**Treasured Time with Your Toddler: A monthly guide to activities.* Jan Brennan. Little Rock, AS: August House Publishers, 1991. 189 pp. Contains a variety of creative activities.

You Can Make It! You Can Do It! One hundred one E-Z holiday craft-activities for children. Ann Peaslee and Julien Kille. Union City, CA: Heian International, 1990. 128 pp. Explains how to make a variety of holiday decorations, crafts, and includes creative activities.

VCRs. Carolyn E. Cooper. New York, NY: Franklin Watts, 1987. 96 pp. Explains how to use video tape and VCR's with instructions for audio dubbing.

Wood. Graham Carrick. Vero Beach, FL: Rourke Enterprises, 1990. 32 pp. Explains a variety of projects made by constructing or carving with wood.

Other resources

These magazines might prove useful to consult for craft ideas: *Crafts 'N Things, American Craft, Ceramics Monthly, Art News,* and *School Arts.*

Ansel Adams, Photographer. Beverly Hills, CA: Filmamerica, Inc., 1981. 1 videocassette, 60 minutes. Ansel Adams, 20th century photographer, discusses his work and demonstrates techniques.

Art and Indian Children of the Dakotas: An introduction to art and other ideas. Arthur Aniotte. For sale from the Superintendent of Documents, US GPO, 1982, Book 5. U.S. Department of the Interior, Bureau of Indian Affairs, Aberdeen Area Office, Aberdeen, SD.

Big A, The: Getting ideas. Lincoln, NE: Great Plains National Instructional Television Library, 1987. 1 videocassette, 15 minutes. Includes a visit to the zoo to draw animals and a visit to see a sculptor and a painter to learn how artists get ideas.

E-Z Bread Dough Sculpture. Torrance, CA: Morris Video, 1988. 1 videocassette, 20 minutes. My Fun Pack #416. For ages 4–8, shows bread dough craft.

Making Playthings (VHS CU 512). Los Angeles, CA: Concord Video, 1985. 1 videocassette, 60 minutes. Shows how to make playthings for kids.

Media Magic: Filmstrip making "center-in-a-box." Tucson, AZ: Zephyr Press, 1982. A kit that contains a poster, 50 feet of reusable film, 12 slide mounts, and 8 colored pens so that children can make their own filmstrips and slides.

Painting without a Brush. Julie Abowitt. Torrance, CA: Morris Video, 1988. 1 videocassette, 20 minutes. For ages 4–8, shows how to paint with string, sponges, and other objects.

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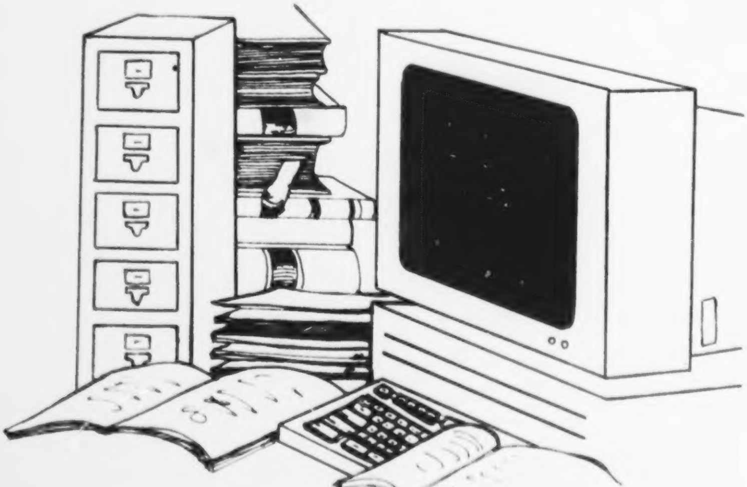
Exploring science in the library

Exploring science through using the libraries in your area can be exciting for you and your curious child or class of students. Depending on the age of the children involved and your location, you may have several areas to explore: your public library, a school library, special libraries such as historical libraries, and college or university libraries. Thanks to the advances in computerizing information and it's availability through networking systems, you may be able to access the holdings of libraries far distant from you.



Learning library skills is much like developing any other skills. You need to ask questions, gain knowledge, and try out what you've learned. Because libraries have undergone so much change in recent years, many adults are learning new library skills at the same time that children are learning them.

One part of learning to use a library is to familiarize yourself with the print holdings. These consist of fiction and nonfiction, reference materials, magazines, and vertical files. Most librarians would be pleased to show you and a child or a group of students around the library and help you feel comfortable there. If you don't have a library card, they will give you application forms and help you become a fully certified user!

Although you can check out materials for a special child on your adult library card or may be able to check out a collection of books on a teacher's card, getting children library cards of their own is a good idea. It is an important step in making the child an independent library user with responsibilities for the care and return of books.

Often the library's fiction holdings are simply housed alphabetically by author. Your special child may have "favorite" authors already. You can find that section of the shelf and check out a new book by that author or an old favorite to read again and enjoy.

Sometimes the child knows the name of a book but can't remember who wrote it. This is a good way to introduce the child to a computerized card catalog. Although it may be faster and simpler for the adult to enter the information, if the child is old enough, the adult can add a great deal to the child's skills in independent learning by letting the child enter the data him- or herself.

Each library system is different, but usually the computerized catalog will have a screen displayed that asks you to indicate whether you want to search for information by title, author, or topic. Once you make that choice, you type in needed information, and the computer screen will show a listing of holdings with call numbers so that you can locate a particular book. Sometimes a second screen shows more detailed information about a book, including the publisher, copyright date, number of pages, and perhaps a brief description.

If your local library has not computerized its holdings, you will be able to assist the child by using the card catalogue which has card sections alphabetically by title and by author.

Building this skill of locating a favorite title or author in the card catalogue or on the computer gives the child confidence in his or her ability to effectively use the library.

For the older child, the library is an excellent place for learning independent research skills. Perhaps there is a school assignment in which the child needs to write a "report." Perhaps in Scouts the child has been asked to investigate a topic. Maybe something on the television news or an article in the newspaper has suggested a subject that the child wants to investigate further. The child may have seen a bug, bird, or butterfly and want to know what type it was. Any of these events may suggest that an exploration to the library is in order to investigate its nonfiction holdings.

Whether the child is preparing a written report or simply satisfying his or her curiosity, it's a good idea to begin the habit of using a notebook. Jotting down the title, author, call number, and pages consulted will make it easy to find the information again, if needed.

Narrowing a topic and doing a materials search are learned skills, and the earlier a child begins developing these skills, the better. For example, if your child is a fourth grader and is asked to prepare a report on marine life, simply typing in "oceans" as the descriptor for a computer word search may yield a huge number of books. Typing "killer whale juvenile" may greatly shorten the list to a more appropriate number.

Many libraries use the Dewey Decimal Classification System. Although it is not necessary to learn the complete set of numbers, knowing the general classifications can be very useful.

Dewey decimal classification system

General Works	000–099
Philosophy	100–199
Religion	200–299
Social Studies	300–399
Language	400–499
Pure Science	500–599
Technology	600–699
The Arts	700–799
Literature	800–899
History	900–999
Biography	B
Fiction	FIC

Other libraries use the Library of Congress Classification. This is an alphabetical rather than a numerical system. For example: A =

General Works; B = Philosophy, Religion; C = History and auxiliary sciences. If your library uses this system, you will want to help your child become familiar with it.

Depending on the topic, there are useful specialized dictionaries and encyclopedias. A few examples of specialized advanced reference books that can be very helpful when researching a specific topic are: *Dictionary of American History*; *What People Wore: A Visual History of Dress from Ancient Times to Twentieth-Century America*; *The New World Encyclopedia of Cooking*; *The Encyclopedia of Literary Characters*; *The Encyclopedia of Sports*; and *The Milton Cross New Encyclopedia of the Great Composers & Their Music*. Your librarian can tell you if there is a special index of magazines on your topic such as the Art Index or National Geographic Index.

If a child is interested in some aspect of local history, you may want to consult your library's newspaper section. Once a newspaper is no longer current, the pages are copied on microfilm and stored in that form. Your curious child will need to learn how to access past issues and to find out if the paper provides an index by subject for each year. *The New York Times* is available from 1851 to the present on microfilm. It has an excellent index to help you find specific information.

Advanced students way also need to learn more about accessing government documents, skimming through abstracts, or finding materials in collections such as Familiar Quotations. There are specialized Almanacs and Yearbook, Biographies, and Geographical sources.

Other reference materials can be helpful too. Rather than copy out a section from an encyclopedia and rewrite it in one's own words, a child may find more exciting and useful material in a current magazine such as *Oceans*, *Sea Frontiers*, or *Sea Secrets*. Each library has its own system for identifying magazines and periodicals with back issues circulating more freely than current issues. Your child may need to use a *Reader's Guide to Periodical Literature* or a computer program such as *Un Cover* to locate appropriate magazines.

Your librarian may also have a vertical file of clippings and pamphlets on some topics of general interest that you can use. If your library does not have the information you need, the librarian can help you request it through an interlibrary loan.

Most libraries also house nonprint materials such as video and cassette tapes. These may be recordings of favorite books, popular movies, and documentaries and nature shows. One or more of these might provide information on a topic of interest.

Making a library treasure hunt map: Step one

Once you have reviewed all aspects of the library with your child, why not plan a "treasure hunt" in three steps to check on your curious child's progress in learning to make the most of a library?

Step one involves the treasure map. Prepare a floor plan map of your most frequently used local library. Ask your child to put the numeral of the items listed below in the correct location on the floor plan.

1 Card catalog (or computer access catalog)
2 Periodicals
3 Vertical or pamphlet files
4 Fiction
5 Biography
6 Special reference sections
7 Nonprint materials
8 Rest rooms and drinking fountain
9 Copy machines

When you feel your child is familiar enough with the local library and it's contents, quiz him or her on more detailed components of the library.

Giving a library treasure hunt quiz: Step two

Step two is a check for understanding of the Dewey Decimal Classification System that many libraries use. This short quiz will help assess your curious child's familiarity with it.

In what numbered section would you browse for books on the following topics:

Sculpture?	Ans. 700's
History of the United States?	Ans. 900's
A book on General Grant?	Ans. B
A chemistry book?	Ans. 500's
A collection of poetry?	Ans. 800's

Lastly, set up a fun treasure hunt game at the library, taking in all the information and details learned by the child with an ultimate treasure hidden amongst the stacks!

Finding a library treasure: Step three

Now you're ready for the final phase of the library treasure hunt. You can pick any books you wish for this final step, including your "treasure" tucked in the page of the final book.

Using the card catalogue or the computerized listing of books, ask your special child to locate a book by author or title.

You may substitute any books that you wish, but here is an example of how to do it:

1. Find any book written by Beverly Cleary.
2. Find a copy of *Ranger Rick Magazine.*
3. Find a copy of *A Wrinkle in Time.*
4. Find a book of poetry by Shel Silverstein.
5. Find a nonfiction book about whales.

The prize might be a ribbon attached to a small paper treasure chest with the child's name written on it and the words "I know how to find treasures in the library!" This can be tucked in the final book you include in the above treasure hunt.

Finding the information is only part of the independent research process. Often the child will want to share the information learned with others. Then it is necessary to decide on a format, organization, and presentation. Many of the references that follow will help a child make decisions about the sharing of information. Since a good library puts so much information at the child's disposal, your exploration here is tremendously important and deserves special care and attention.

Another chapter of this book that might be of interest while you are doing your library exploration is Chapter 12 "Exploring Science through Writing."

Resource books

Activities Almanac: Daily ideas for library media lessons. H. Thomas Walker and Paula K. Montgomery (Editors). Santa Barbara, CA: ABC-CLIO, 1990. 283 pp. Contains ideals compiled from a monthly column of School Library Media Activities.

**Armando Asked, "Why?"* Jay Hulbert and Sid Kantor. Milwaukee, MN: Raintree Childrens Books, 1990. 23 pp. Tells a story of how a family is too busy to take their child to the library, but after being introduced to the librarian, he is able to find the books he wants.

Basic Library Skills (2nd. ed.). Carolyn Wolf and Richard Wolf. Jefferson, NC: McFarland, 1986. 141 pp. Provides an orientation to the library.

Basic Media Skills through Games. Irene Wood Bell and Jeanne E. Weickert. Littleton, CO: Libraries Unlimited, 1985. 2 volumes. Contains games to teach library skills.

Books and Libraries. Jack Knowlton. New York, NY: HarperCollins, 1991. 36 pp. Gives a history of books and libraries.

Brainstorms and Blueprints: Teaching library research as a thinking process. Barbara K. Stripling and Judy M. Pitts. Littleton, CO: Libraries Unlimited, 1988. 181 pp. Provides useful reinforcement of library skills for secondary students.

Check It Out! The book about libraries. Gail Gibbons. San Diego, CA: Harcourt Brace Jovanovich, 1985. 32 pp. Offers an introduction to libraries.

Choose, Use, Enjoy, Share: Library media skills for the gifted child. Phyllis B. Leonard. Littleton, CO: Libraries Unlimited, 1985. 153 pp. Contains information skills.

Clara and the Bookwagon. Nancy Smiler Levinson. New York, NY: Harper & Row, 1988. 64 pp. Tells a story of how a horse drawn book wagon visits a farm with the first traveling library.

Day in the Life of a Librarian, A. David Paige. Mahwah, NJ: Troll Associates, 1985. 32 pp. Follows a typical day of the chief librarian in an Illinois public library.

Developing Library Skills. Ester Lakritz. Carthage, IL: Good Apple, 1989. 108 pp. Consists of an activity book on library skills for students in grades 4–8.

Dewey Dynamite. Sherry R. Crow. Book Lore (distributed by ECS Learning Systems, Inc.), 1987. San Antonio, TX: 32 pp. Presents research skills activities for each Dewey discipline for individuals or groups of children in grades 3–6.

Educating the Public Library User. Compiled and edited by John Lubans, Jr. Chicago, IL: American Library Assn., 1983. 145 pp. Offers information about using public libraries.

Find It Fast: How to uncover expert information on any subject. Robert I. Berkman. New York, NY: Perennial Library, 1990. 330 pp. Tells how to find library information.

Find It! The inside story at your library. Claire McInerney. Minneapolis, MN: Lerner Publications Co., 1989. 55 pp. Describes the resources to be found in a library and tells how to use them.

Fire! The library is burning. Barry D. Cytron. Minneapolis, MN: Lerner Publications Co., 1988. 56 pp. Describes the 1966 fire at the library of the Jewish Theological Society in New York City and the rescue operation in which neighbors and the city took part.

***First Research Projects.* Nancy Polette. Book Lore (distributed by ECS Learning Systems, Inc.), 1984. San Antonio, TX: 32 pp. Contains beginning research projects for students in grades K–3.

Guide to Independent Research, A. Phyllis J. Perry (Editor). Mobile, AL: GCT Publications, 1990. 66 pp. Explains how to use the tools of library research.

Guide to the Use of Libraries and Information Sources. Jean Key Gates. New York, NY: McGraw-Hill, 1983. 338 pp. Offers a guide on how to use books and libraries.

Help Is on the Way for—Library Skills. Marilyn Berry. Chicago, IL: Childrens Press, 1985. 46 pp. Provides an orientation to library skills.

Help Is on the Way for—Written Reports. Marilyn Berry. Chicago, IL: Childrens Press, 1984. 44 pp. Shows the steps in writing a report including how to do library research.

Holidays: Lessons and activities for library media centers. H. Thomas Walker and Paula K. Montgomery (Editors). Santa Barbara, CA: ABC-CLIO, 1990. 285 pp. Contains selected activities that were published in *School Library* monthly magazine.

Hooked on Independent Study! A programmed approach to library skills for grades 3 through 8. Marguerite Lewis. West Nyack, NY: Center for Applied Research in Education, 1990. 248 pp. Provides detailed library skills.

Hooked on Research! Ready-to-use projects & crosswords for practice in basic library skills. Marguerite Lewis. West Nyack, NY: Center for Applied Research in Education, 1984. 252 pp. Contains ideas for teaching library skills.

How to Become an Expert: Discover, research, and build a project in your chosen field. Maurice Gibbons. Tucson, AZ: Zephyr Press, 1991. 136 pp. Consists of a step-by-step guide on investigating problems with reproducible pages.

How to Write a Great School Report. Elizabeth James. New York, NY: Lothrop, Lee & Shepard Books, 1983. 79 pp. Tells how to choose a topic, find information in the library, write, and revise.

I Can Be a Librarian. Carol Green. Chicago, IL: Childrens Press, 1988. 29 pp. Describes different types of libraries and the work of librarians.

Know It All: Resource book for kids, The. Patricia R. Peterson. Tucson, AZ: Zephyr Press, 1989. 144 pp. Provides a valuable resource to improve independent learning skills, used much like a dictionary, with simple definition, example, and/or illustration.

Let's Go to the Library. Lisl Weil. New York, NY: Holiday House, 1992. 32 pp. Gives a brief history of libraries and describes what goes on in a library.

Let's Visit a Printing Plant. Catherine O'Neill. Mahwah, NJ: Troll Associates, 1988. 32 pp. Explains the processes that produce books that are shipped to stores, schools, and libraries.

**Librarians A to Z.* Jean Johnson. New York, NY: Walker and Company, 1988. 48 pp. Uses the letters of the alphabet to introduce the work of librarians.

Libraries. Patricia Fujimoto. Chicago, IL: Childrens Press, 1984. 47 pp. Explains how to use libraries.

Library Media Skills: Strategies for instructing primary students. Alice R. Seaver. Littleton, CO: Libraries Unlimited, 1991. 147 pp. Contains resources for teaching information skills.

Library: Your teammate. Philly Murtha. Mankato, MN: Creative Education, 1985. 32 pp. Offers a teenage orientation to the library.

**Mostly at the Library.* Ruth Shaw Radlaver. New York, NY: Simon & Schuster Books for Young Readers, 1988. 32 pp. Tells a story of how a 4-year-old and father check out 10 books from the library.

**Once Inside the Library.* Barbara A. Huff. Boston, MA: Little, Brown, 1990. 32 pp. Tells a story of the joys of books and reading.

On Line Searching in the Curriculum: A teaching guide for library/media specialists and teachers. Beverly Hunter and Erica K. Lodish. Santa Barbara, CA: ABC-CLIO, 1989. 219 pp. Tells how to do on-line library searches.

Ready for Reference: Media skills for intermediate students. Barbara Bradley Zlotnick. Littleton, CO: Libraries Unlimited, 1984. 274 pp. Offers an introduction to reference skills.

Ready-to-use Library Skills Games: Reproducible activities for building location and literature skills. Ruth V. Snoddon. West Nyack, NY: Center for Applied Research in Education, 1987. 185 pp. Teaches the reader games to teach library skills.

Reference Puzzles and Word Games for Grades 7–12. Carol Smallwood. Jefferson, NC: McFarland, 1991. 190 pp. Contains a list of library activities.

Research Book of the Fifty States, The. Nancy Polette. Book Lore (distributed by ECS Learning Systems, Inc.), 1991. San Antonio, TX: 32 pp. Offers research activities for students in grades 4–7 that can be applied to any state.

Research Made Easy: A guide for students and writers. Robert D. Matzen. New York, NY: Bantam Books, 1987. 248 pp. Provides an introduction to doing library research.

Savvy Student's Guide to Library Research. Judith M. Pask and Robert J. Kovac. West Lafayette, IN: Purdue University, 1990. 84 pp. Gives an orientation to the library for college students.

School Library Program in the Curriculum, The. Selected by Ken Haycock. Littleton, CO: Libraries Unlimited, 1990. 169 pp. Contains selected articles.

Search: A research guide for science fairs and independent study. Connie Wolfe. Tucson, AZ: Zephyr Press, 1988. 94 pp. Simplifies organization of research.

So You Have to Write a Term Paper! Nancy Everhart. New York, NY: Franklin Watts, 1987. 124 pp. Explains term paper writing through the steps of library research, note taking, making a rough draft, and editing.

Tall Tale Research Book, The. Virginia Mealy. Book Lore (distributed by ECS Learning Systems, Inc.), 1983. San Antonio, TX: 32 pp. Offers an introduction to reference tools for students in grades 4–7 using the tall tale theme.

Teaching Library Media Skills: An instructional program for elementary and middle school students. H. Thomas Walker and Paula Kay Montgomery. Littleton, CO: Libraries Unlimited, 1983. 207 pp. A guide to teaching media skills.

Tracking the Facts: How to develop research skills. Claire McInerney. Minneapolis, MN: Lerner Publications Co., 1990. 64 pp. Explains how to do public library computer searches.

**Visit to the Library, A.* Sylvia Root Tester. Chicago, IL: Childrens Press, 1985. 31 pp. Tells of how a group visits the library to see a puppet show, hear a story, and check out books.

What You Need to Know about Developing Study Skills, Taking Notes and Tests, Using Dictionaries, and Libraries. Marcia J. Coman and Kathy L. Heavers. Lincolnwood, IL: National Textbook Co., 1991. 91 pp. Discusses ways to develop study skills.

Word for Word I. Susan Hovis and Bonnie Domin. Tucson, AX: Zephyr Press, 1988. 80 pp. Contains 10 units of activities that combine creative thinking and research skills.

Word for Word II. Susan Hovis and Bonnie Domin. Tucson, AZ: Zephyr Press, 1990. 80 pp. Contains 10 units of activities that combine creative thinking and research skills.

Young Writer's Handbook, The. Susan J. Tchudi. New York, NY: Scribner, 1984. 156 pp. Discusses how to write reports and edit.

Other resources

How My Library Grew by Dinah. Bronx, NY: H. W. Wilson, 1990. 1 videocassette. Neither Dinah nor her teddy bear have ever visited a library before until one is built down the street.

How to Use the Library. Mark Schaeffer. Bronx, NY: H. W. Wilson, 1989. 1 videocassette, 20 minutes. Explains basic research and how to use the periodical index.

Glossary

acid Any one of a class of substances that is sour in taste, soluble in water, and will redden litmus.

aerate To combine or charge with gas.

aerodynamics The branch of dynamics that deals with the motion of air and other gases and the forces acting on bodies that move through the air.

altitude The vertical elevation of an object above a given level, such as sea level.

aluminum sulfate A colorless salt made by treating bauxite with sulfuric acid, commonly used for such things as purifying water or sizing paper.

aquarium A tank of water in which living aquatic plants and animals are kept.

astronomy The science that deals with celestial bodies such as the moon, planets, and stars.

azimuth An arc of the horizon measured clockwise between a fixed point on the horizon and the vertical circle passing through the center of an object.

baffle A circular, domed plate that hangs loosely above a bird feeder, preventing squirrels from getting to the seeds in the feeder.

barometer An instrument used to measure the weight or force of air distributed over the surface of the earth.

base A compound, such as lime or ammonia, that reacts with acids to form salts.

Big Dipper A constellation of stars, called *Ursa Major*, that resembles a drinking cup with a long handle.

bleaching Making white or lighter in color.

botany The science that deals with plant life.

calcite Calcium carbonate that is crystallized in hexagonal form.

call numbers The numbers assigned by an established system to books in a library collection so that they can be located on the shelves.

card catalogue A catalogue, with information entered on cards that contain data about the title, author, and subject for all the holdings in a library collection.

carnivorous Meat-eating. The name given to designate those plants and animals that eat flesh.

cartography The art of making charts or maps.

Cassiopeia A constellation of stars found not far from *Polaris* that looks like a "W" in the sky.

chemical reaction The result or change made by combining two or more chemicals.

chemistry The science that deals with the composition of substances and the changes that they undergo.

chlorophyll The green coloring visible in leaves.

classify To organize by some established system.

climate The average condition of the weather in a place over a period of years, including information such as temperature and rainfall.

comet A luminous heavenly body, usually with a long tail, following an orbit around the sun.

compass A device for determining directions by means of a magnetic needle swinging on a free pivot and pointing to magnetic north.

conduction Transmitting heat or electricity by means of a conductor.

conductor A substance capable of transmitting electricity or heat.

constellation Any one of a number of groups of fixed stars.

crystals Bodies formed by chemical elements or compounds solidifying so that they have symmetrically arranged plane surfaces.

cyclometer An instrument for recording the revolutions of a bicycle wheel to measure the distance traveled.

Cygnus Group One of a number of fixed star constellations, which includes the bright star, Deneb, and which looks like a swan with outspread wings.

declination The angle that the magnetic compass needle makes with the geographical meridian.

dense Compact or having its parts tightly packed together.

density The quantity of anything per unit of volume

Dewey Decimal Classification System A system used by libraries to group their holdings into large general and then more specific categories.

Dipper Group The constellations of fixed stars that contain both the Big and Little Dippers.

Draco Group The constellation of fixed stars that resemble the shape of a dragon in the sky.

drainage layer Often a layer of gravel placed beneath the soil in which there is a plant to allow water to drain away from the roots.

electricity One of the fundamental quantities in nature consisting of elementary particles called electrons and protons that gives rise to a field of force.

emulsion An oily mass in suspension in a watery liquid.

energy Power, efficiently and forcibly exerted, capable of performing work.

ethology The study of animal behaviors.

fossil Any trace of a plant or animal from past geological ages that has been preserved.

friction The resistance of motion between two bodies in contact.

geography The collective, natural feature of an area.

geology The science that studies the history of the earth and its life, especially as recorded in rocks.

gravitation The phenomenon that two material bodies, if free to move, will be accelerated toward each other.

habitat The natural location where a plant or animal normally lives.

hand lens A magnifying glass that is held in the hand.

hardness test A test that determines the hardness of a substance by its ability to scratch the surface of another substance.

hydroponics The growing of plants with roots in a solution instead of in soil.

illusion A misleading image presented to the vision.

International Date Line The 180th meridian, which marks the point where one day ends and another begins.

ion An electrically charged atom or group of atoms.

kindling temperature The temperature at which a substance will ignite and burn.

latitude The angular distance on a meridian measured in degrees north and south from the equator.

light The essential condition of vision, the opposite of darkness, the emanation from a light-giving body.

Little Dipper A constellation of fixed stars, called *Ursa Minor*, located near the Big Dipper, and resembling a cup with a long handle.

longitude The portion of the equator, intersected between the meridian of a given place and the prime meridian, expressed in degrees.

lunar eclipse The shrouding of light caused by the moon's entering the earth's shadow. A lunar eclipse occurs when the earth is between the moon and the sun.

lune A three-line poem that contains three words in lines 1 and 3 and five words in line 2.

magnesium sulfate A compound of magnesium, sulfur, and oxygen, known as Epsom salts.

magnetic north The direction indicated by the north seeking pole of the horizontal magnetic needle.

magnetism A property of the molecules of certain substances, such as iron, that can attract other nonmagnetic substances.

meridian The highest point attained by a heavenly body.

meteor A celestial body that enters the earth's atmosphere with great speed, light, and heat generated by the resistance of the air.

meteorite A stony or metallic body that has fallen to earth from outer space.

mineral Any chemical element or compound occurring naturally as a product of inorganic processes.

nerve cell A small mass of protoplasm making up the bands of tissue that connect parts of the nervous system with other organs and conducts impulses.

new moon The phase of the moon when its dark side is facing the earth. In this phase, the moon will appear invisible or as a thin, curved sliver.

northern lights Ionization of atmospheric atoms due to activity of the sun, producing a luminous phenomenon consisting of streamers of light in the sky. The northern lights are best seen in polar regions at night. Also called the *aurora borealis.*

odometer An instrument that measures distance traveled.

optics The science dealing with light; its genesis and propagation, the effects it suffers and produces, and other phenomena such as vision.

Orion Group A constellation of fixed stars resembling a hunter wearing a belt and followed by a dog.

oxidation The state of being oxidized.

oxidize To combine with oxygen.

oxygen An element occurring in the atmosphere as an odorless, tasteless, colorless gas.

paleontology The science that deals with the life of past geological periods.

Pegasus Group A constellation of fixed stars that resembles a winged horse.

physics The branch of knowledge that deals with the physical world and its phenomena.

planetarium A facility using projections on a ceiling to display the movements of celestial bodies.

Polar Group The constellation of stars around the Pole Star or North Star.

Polaris The name given to the north star, found in the constellation known as the Little Dipper.

prime meridian An imaginary vertical line that runs from the north to the south poles, and from which degrees of longitude are measured. The commonly accepted prime meridian is Greenwich, England.

protractor An instrument used for measuring angles on paper.

radio waves The transmission and reception of signals by means of electrical waves without a connecting wire.

radium An intensely radioactive metallic element.

radius The distance from the center of a circle to the outside edge.

reaction A chemical transformation or change.

receptors A group of cells that receive stimuli.

reflection The return of light or sound waves from surfaces.

refraction The deflection of light from a straight path in passing from one medium to another.

salinity The degree of saltiness.

satellite An attendant body, revolving around a larger one.

Scorpio Group A constellation of fixed stars that resembles a scorpion in the sky.

sense organs An organ specialized to receive certain stimuli.

silver sulfide A combination of silver and sulfur commonly called "tarnish" or the dark stain that appears on silverware.

spatial Pertaining to space.

specimen A sample, or one of a number, designed to show something about the quality of the whole.

spore A reproductive body produced by plants.

stalactite A deposit of calcium carbonate hanging from the roof or sides of a cave.

stalagmite A deposit of calcium carbonate formed on the floor of a cave.

stimulus Any agent or environmental change capable of influencing the activity of living protoplasm. Plural *stimuli*.

suet feeder A bird feeder where pieces of suet, or fat, are placed for birds to eat.

sun dial An instrument to show the time of day by the shadow of its style, or *gnomon*.

terrarium An enclosure with earth for keeping or raising plants or animals indoors.

topography The configuration of a surface, including such features as its relief, and the position of streams and lakes.

transpiration The giving off of vapor from the surface of green plants.

true north The direction of the north pole from anywhere on earth.

vivarium An enclosure for keeping or raising plants or animals indoors.

volume Space that is occupied and measured by cubic units.

zenith The point of the heavens that is directly above the observer.

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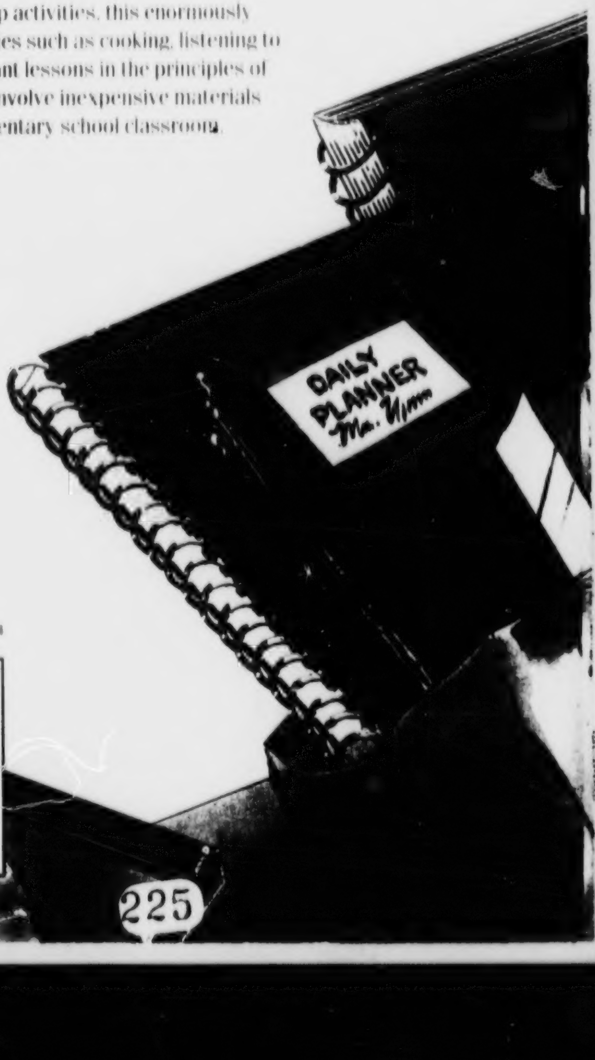

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